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OFFICE OF WATER RESEARCH AND TECHNOLOGY

# SELECTED WATER RESOURCES ABSTRACTS

VOLUME 13, NUMBER 16
AUGUST 15, 1980

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# SELECTED WATER RESOURCES ABSTRACTS

A semimonthly publication of the
Office of Water Research and Technology
U.S. Department of the Interior

**VOLUME 13, NUMBER 16**
AUGUST 15, 1980

W80-05101 -- W80-05400

The Secretary of the U.S. Department of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through August 31, 1983.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most our our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

# FOREWORD

**Selected Water Resources Abstracts,** a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographic citation and a set of identifiers or descriptors which are listed in the **Water Resources Thesaurus.** Each abstract entry is classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

WRSIC IS NOT IN A POSITION TO PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

**Selected Water Resources Abstracts** is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Office of Water Research and Technology.

To provide SWRA with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas.

The input from these Centers, and from the 54 Water Resources Research Institutes administered under the Water Research and Development Act of 1978, as well as input from the grantees and contractors of the Office of Water Research and Technology and other Federal water resource agencies becomes the information base from which this journal is derived.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C. 20240

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05 WATER QUALITY MANAGEMENT AND PROTECTION

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07 RESOURCES DATA

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ABSTRACT SOURCES

# SELECTED WATER RESOURCES ABSTRACTS

## 1. NATURE OF WATER

### 1B. Aqueous Solutions and Suspensions

**CONCENTRATION AND FRACTIONATION OF HYDROPHOBIC ORGANIC ACID CONSTITUENTS FROM NATURAL WATERS BY LIQUID CHROMATOGRAPHY,**
Geological Survey, Lakewood, CO. Water Resources Div.
E. M. Thurman, and R. L. Malcolm.
Available from Supt. of Documents, GPO, Washington, DC 20402, Price, $1.25. Geological Survey Water-Supply Paper 1817-G, 1979. 16 p, 4 Fig, 2 Tab, 13 Ref.

Descriptors: *Distillation, *Organic acids, *Chromatology, *Adsorption, *Analytical techniques, Water properties, Instrumentation, Methodology, Separation techniques, Gels, Hydrogen ion concentration, Fulvic acids, Phenols, Humic acids, Conductivity, *Liquid chromatography, Hydrophobic organic acids.

A scheme is presented which uses adsorption chromatography with pH gradient elution and size-exclusion chromatography to concentrate and separate hydrophobic organic acids from water. A review of chromatographic processes involved in the flow scheme is also presented. Organic analytes that appear in each aqueous fraction are quantified by dissolved organic carbon analysis. Hydrophobic organic acids in a water sample are concentrated on a porous acrylic resin. These acids usually constitute approximately 30 to 50 percent of the dissolved organic carbon in an unpolluted water sample and are eluted with an aqueous eluent (dilute base). The concentrate is then passed through a column of polyacryloylmorpholine gel, which separates the acids into high- and low-molecular-weight fractions. The high- and low-molecular-weight eluates are reconcentrated by adsorption chromatography, then are eluted with a pH gradient into strong acids (predominately carboxylic, acids) and weak acids (predominately phenolic compounds). For standard compounds and samples of unpolluted waters, the scheme fractionate humic substances into strong and weak acid fractions that are separated from the low molecular weight acids present. A new method utilizing conductivity is also presented to estimate the acidic components in the methanol fraction. (Kosco-USGS)
W80-05301

## 2. WATER CYCLE

### 2A. General

**HYDROLOGIC CHARACTERISTICS OF AUSTRALIAN STREAMS,**
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W80-05120

**POINT BAR AND FLOODPLAIN FORMATION OF THE MEANDERING BEATTON RIVER, NORTHEASTERN BRITISH COLUMBIA, CANADA,**
Wollongong Univ. (Australia). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W80-05144

**VERIFICATION OF MATHEMATICAL AND PHYSICAL MODELS IN HYDRAULIC ENGINEERING.**
Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978. American Society of Civil Engineers, New York, 1978. 887 p.

Descriptors: *Conferences, *Hydraulics, *Mathematical models, *Hydraulic models, *Model studies, *Statistical models, Hydraulic engineering, Groundwater, Open channel flow, Calibrations, Groundwater movement, Roughness(Hydraulic), Natural streams, Aquifers, Porous media, Open channels, Water management(Applied), Navigation, Land use, Estuaries, Tidal waters, Hydraulic structures, Lakes, Rivers, Watersheds(Basins), Runoff, Analytical techniques, Analysis, Numerical analysis, Unsteady flow, Sediment transport, Thermal plumes.

The purpose of this conference was to focus attention on verification of mathematical and physical models in hydraulic engineering. Subject areas covered by the 96 papers included: societal obligations of a people-serving profession, current practices and data basis for the verification of effluent models, flow model calibration, groundwater model calibrations or parameter identification, modeling for water quality management, models for navigation project planning, application of groundwater models to actual field situations, modeling of tidal and estuarine circulation and water quality problems, computational hydraulics, water quality analysis, modeling of prototype testing of submerged hydraulic structures in a lake regime, prototype verification of models for hydraulic structures, tidal hydraulics, unsteady flow, sediment models, hydrologic models, and land use models. (See W80-05160 thru W80-05241) (Humphreys-ISWS)
W80-05159

**SEDIMENT MOVEMENT IN A SMALL HUMID WATERSHED,**
Hawaii Univ., Honolulu.
For primary bibliographic entry see Field 2J.
W80-05220

**A SEDIMENT YIELD ROUTING MODEL,**
Science and Education Administration, Temple, TX.
For primary bibliographic entry see Field 2J.
W80-05221

**FIELD TEST OF A DISTRIBUTED SEDIMENT YIELD MODEL,**
Science and Education Administration, Oxford, MS. Sedimentation Lab.
For primary bibliographic entry see Field 2J.
W80-05222

**APPLICATION OF COSSARR MODEL IN CENTRAL JAVA,**
Engineering Consultants, Inc., Denver, CO.
Y. Au-Yeung, J. Loebis, and S. Komarawinata.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 715-722, 1978. 3 Fig, 7 Tab, 2 Ref.

Descriptors: *Model studies, *Watersheds(Basins), *Hydrologic systems, *Synthetic hydrology, Streamflow, Hydrology, Computer models, Runoff, Soil moisture, Evapotranspiration, Base flow, Infiltration, *Java, Model calibration.

The watershed model portion of the COSSARR model provided a useful tool in streamflow extension for three river basins in central Java. The successful use of the model, like all other hydrologic models, is determined largely by the quantity and quality of the available data as demonstrated by the difference in the computed runoff volumes from using only four years of mean daily flow data as compared with six years of actual flow data in the Lukulo watershed. Without a reasonable lenght of concurrent observed streamflow data and observed rainfall data, the accuracy of the model verification is difficult and uncertain. Another difficulty involved in applying the model was in the filling and adjusting the missing rainfall data for period when localized thunderstorms produce most of the rainfall. Four years of observed hydrologic data is too short a period to adequately verify the runoff-rainfall relationship of any watershed, therefore, it was planned to recalibrate the model in 1980. One hopes there will be at least ten years of observed hydrologic data for better model calibration. (See also W80-05159) (Humphreys-ISWS)
W80-05226

**UPPER ST. JOHNS RIVER BASIN WATER MANAGEMENT MODEL,**
St. Johns River Water Management District, Palatka, FL. Engineering Div.
C. C. Tai.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 729-736, 1978. 4 Fig, 4 Ref.

Descriptors: *Water management(Applied), *Florida, *Model studies, *River basins, Hydrologic systems, Watersheds(Basins), Runoff, Water balance, Management, Hydrograph analysis, Base flow, Rainfall, Evapotranspiration, Computer models, Soil water, Surface runoff, Infiltration, Analytical techniques, *St. Johns River(FL).

The Upper St. Johns River Basin covers a drainage area of about 2,000 square miles in east central Florida within the boundary of the St. Johns River Water Management District. The main river channel runs northerly with an average hydraulic gradient of 0.16 feet per mile for about 95 miles from the headwater near Melbourne. The Upper St. Johns Basin Model (USJM) has been developed with special consideration given to the extraordinary hydrologic features of the basin. The model was organized so that the hydrologic responses resulting from any change in each element of the project works could be generated. The USJM consists of two major components, namely the USJ runoff model and the USJ routing model. The runoff model generates the runoff hydrograph for each discrete land area from input rainfall data. The routing model modifies this hydrograph by considering the impoundment and transient lag time effects to produce an inflow hydrograph into the main river, and finally computes the discharge hydrograph for each river reach. The valley flow will be simulated with partial differential equations written for overland flow over a grid mesh. The model has been used to simulate two planning units and has produced favorable results. The actual simulation run of the entire Upper St. Johns River Basin has not been performed because the total required data is not yet available. (See also W80-05159) (Humphreys-ISWS)
W80-05227

**THE EFFECT OF PRECIPITATION PATTERNS ON SURFACE RUNOFF,**
California State Dept. of Water Resources, Sacramento.
R. H. Zettlemoyer.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 776-782, 1978. 4 Fig, 4 Ref.

Descriptors: *Precipitation(Atmospheric), *Distribution patterns, *Model studies, *Surface runoff, *California, Hydrology, Runoff, Annual, Analysis, Simulation analysis, River basins, Evaporation, Watersheds(Basins), *Mattole River(CA).

A general hydrologic model was used to evaluate the effect on annual runoff due to variations in precipitation throughout the year. The Mattole River basin in a humid region of California was calibrated to a 15-year period, and then annual rainfall totals were made equal to the minimum, median, and maximum annual totals of the calibration period. The simulation showed that favorable patterns could produce up to 10% greater runoff than an average year, and conversely unfavorable patterns could produce 10% less runoff than a typical year for the Mattole basin. Caution is recommended in extrapolating to other hydrologically different areas. Model studies as described can be useful when verifying water supply forecasts. Another application includes the preparation of water supply forecasts that are based on long-range weather forecasts which contain only trend type

precipitation information. (See also W80-05159) (Humphreys-ISWS)
W80-05233

**LINEARIZED SUBHYDROGRAPHS URBAN RUNOFF MODEL,**
Akron Univ., OH. Dept. of Civil Engineering.
S. Sarikelle, J-S. Chien, and G. L. French.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 783-790, 1978. 6 Fig, 6 Ref.

Descriptors: *Model studies, *Urban runoff, *Hydrograph analysis, *Cities, Mathematical models, Analytical techniques, Analysis, Runoff, Urban hydrology, Hyetographs, Methodology, Runoff coefficient, Watersheds(Basins), Rainfall-runoff relationships, Simulation analysis, Storm water, Linearized subhydrographs method.

A model for the simulation of urban runoff based on the Linearized Subhydrographs Method was verified for the planning and analysis of converging stormwater drainage systems in urban areas. The model simulates hydrographs for continuously recorded rainstorm events as applied to different watersheds of various sizes. The model was applied to various urban watersheds with differing land use characteristics utilizing recorded hyetographs. The simulated hydrographs were then compared to recorded hydrographs. The results indicate that when continuous event hyetographs are utilized, the simulated hydrographs compare well to those results obtained from measured values. (See also W80-05159) (Humphreys-ISWS)
W80-05234

**ASSESSING LAND USE CHANGES WITH AN URBAN RUNOFF MODEL,**
North Virginia Planning District Commission, Falls Church.
H. A. Bonuccelli, and J. P. Hartigan.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 827-835, 1978. 3 Fig, 9 Ref, 1 Append.

Descriptors: *Urban runoff, *Land use, *Model studies, *Effects, Cities, Watersheds(Basins), Management, Hydrographs, Planning, Hydrologic aspects, Environment, Decision making.

The dissemination of reports on successful applications of urban runoff simulation models in 'real-world' settings can be expected to bring about more widespread adoption of computer modeling techniques by the public sector. This paper provided such a case study. It described a regional stormwater management program that has successfully incorporated computer modeling techniques into local decision-making processes. The use of a verified model as an ongoing planning tool in the Four Mile Run Watershed Management Program has yielded many important benefits. It has allowed public works officials in four political subdivisions to view the watershed as an integrated system and has eliminated the traditional 'piecemeal' approach to drainage improvements in the watershed. By addressing complex hydraulic interactions in the watershed, it has enabled the local jurisdictions to determine the downstream impacts of developments throughout the basin. It revealed the importance of a single tributary as a hydraulic control for the flood control channel and indicated that certain parts of the watershed are more sensitive to land use change than others. By demonstrating the inappropriateness of uniform detention ordinances in the basin, it has prevented the expenditure of funds on needless or harmful control measures. (See also W80-05159) (Humphreys-ISWS)
W80-05239

**RUNOFF SIMULATION MODEL: APPLICATION AND VERIFICATION,**
Weston (Roy F.), Inc., West Chester, PA.
D. F. Lakatos, and K. C. Wiswall.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 836-843, 1978. 4 Fig, 1 Tab, 2 Ref.

Descriptors: *Runoff, *Model studies, *Urban runoff, *Maryland, Storm runoff, Urban drainage, Flooding, Watersheds(Basins), Peak discharge, Analytical techniques, Drainage systems, Storm water, Management, *Aberdeen(MD), Penn State Runoff Model.

The initial phase of the Aberdeen, Maryland, study was a thorough investigation of the existing drainage system to provide a full description of the physical characteristics of the system. These physical characteristics are needed for accurate development of the required input for the Penn State Runoff Model. The modeling technique consisted of the following six steps: (1) Collect and analyze existing drainage system information. (2) Select the design storms and the storms needed for calibration/verification. (3) Make calibration/verification runs to determine the accuracy of model coefficients. (4) Model the existing system to pinpoint the critical flooding areas. (5) Input the alternative runoff control techniques for further model analysis. (6) Recommend a set of runoff control techniques based on modeling results and on overall costs. The case study application of this model illustrated its practicality in developing realistic control alternatives for stormwater management. The Town of Aberdeen has begun to correct those components of the two storm drainage systems that were determined to be critical enough to require short-term action. In addition, potential funding sources are being investigated in order that the required overall or long-term system-control recommendation can be implemented. (See also W80-05159) (Humphreys-ISWS)
W80-05240

**COMPARISON OF STORMWATER DETENTION POLICIES,**
Maryland Univ., College Park. Dept. of Civil Engineering.
G. E. Kamedulski, and R. H. McCuen.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 844-853, 1978. 4 Tab, 6 Ref.

Descriptors: *Water management(Applied), *Decision making, *Detention reservoirs, *Water policy, Storm water, Management, Model studies, Storm runoff, Mathematical models, Watersheds(Basins), Hydrology, Flood routing, Storage, Sediment discharge, Urban runoff, Stormwater detention.

A mathematical model was formulated to simulate the response of a detention basin to flow and sediment discharges. The model was calibrated using data obtained from an existing detention basin on a 47-acre watershed in Montgomery County, Maryland. The model was then used to evaluate the response of the detention basin for storms of various intensities and durations and for two land use conditions: a highly pervious, exposed soil condition, and a semipervious, exposed soil condition. Various detention basin design policies were evaluated and the effects of changes in detention basin parameters on detention basin design policies were evaluated. The use of the model resulted in several important conclusions. First, inflow volume has a significant effect on both peak discharge reduction and sediment trap efficiency. Second, hydrologic designs have traditionally been based on both a duration and a frequency. Third, the use of one return period as the basis for a detention basin design policy does not lead to a design that reflects the intent of stormwater management. Fourth, current design policies often establish the required basin storage volume independent of the design characteristics of the riser and outflow pipe. Fifth, sediment trap efficiency was dependent on the volume of inflow sediment and the volume of basin storage. In summary, detention storage is an effective means for controlling the effects on runoff of continued urban expansion. But for detention storage to provide optimum protection and to meet the intent of stormwater management policies, the design policies need to be more comprehensive than most existing policies. (See also W80-05159) (Humphreys-ISWS)
W80-05241

**A DIGITAL OVERLAY TECHNIQUE FOR EVALUATION OF POTENTIAL INFILTRATION AND RECHARGE,**
University of South Florida, Tampa. Coll. of Engineering.
For primary bibliographic entry see Field 4A.
W80-05261

**WATER BUDGETS FOR LAKE SUPERIOR AND WHITEFISH BAY,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05281

**WATER IN THE PENSACOLA, FLORIDA, AREA.**
Geological Survey, Tallahassee, FL. Water Resources Div.
Geological Survey Water-Resources Investigations 79-89 (open-file report), 1979. 16 p, 8 Ref.

Descriptors: *Groundwater resources, *Surface waters, *Florida, *Water quality, *Available water, Freshwater, Rainfall-runoff relationships, Streamflow, Hydrologic budget, Aquifers, Water supply, Water utilization, Industrial wastes, Waste disposal, Cooling, Water resources development, Saline water intrusion, Water pollution, Flooding, Gulf Coastal Plain, *Pensacola area(Fla), Floridan aquifer.

The Pensacola, Florida, area, comprising Escambia and Santa Rosa Counties, has abundant water of good quality. Most of the freshwater used, about 101 million gallons per day, comes from the surficial sand-and-gravel aquifer. The deeper Floridan aquifer locally contains saltwater, and is used in places for industrial waste disposal. Surface water is used for cooling and waste disposal, but is available for additional development. Water problems around Pensacola are localized, but they include saltwater encroachment, contamination of ground water by industrial wastes, high iron concentration, corrosiveness, and nitrate in ground water, and flooding. These problems point up the need for continued monitoring of the water resource. (Kosco-USGS)
W80-05298

## 2B. Precipitation

**COMPARISON OF GENERALIZED ESTIMATES OF PROBABLE MAXIMUM PRECIPITATION WITH GREATEST OBSERVED RAINFALLS,**
National Weather Service, Silver Spring, MD.
J. T. Riedel, and L. C. Schreiner.
NOAA Technical Report NWS 25, March 1980. 70 p, 40 Fig, 5 Tab, 15 Ref.

Descriptors: *Probable maximum precipitation, *Precipitation(Atmospheric), *Rainfall, *Storms, *Meteorology, Appalachian mountain region, Gulf of Mexico, Snake River, California, North Dakota, Regional analysis, United States.

The relationship between probable maximum precipitation (PMP) estimates and observed maximum rainfalls was investigated for two regions of the U.S., east of the 105th meridian and west of the Continental Divide. Storms used in the study were those of record having point or area rainfall depths that are greater than or equal to 50% of PMP. In the East, 177 storms were identified that met this criterion and rainfall amounts were well distributed over the range of durations and area sizes. Approximately 1% of the Eastern storms were within 20% of PMP. A smaller storm sample was

obtained in the West, and detailed comparisons analogous to those in the East cannot be made. Despite this smaller Western storm sample, there were more cases in the West of greater than or equal to 50% of PMP for 10 sq mi areas (6 and 24 hours) than in the East. A rough comparability in PMP between the East and West was observed in comparisons of PMP values with the values for the 100 yr occurrence. These ratios were low in areas of frequent heavy rains such as the Cascade-Sierra slopes, the Appalachians, and the Gulf of Mexico coastal regions. Conversely these ratios were high in areas where heavy rains are uncommon such as the central valley of California, the Snake River and North Dakota. (Seigler-IPA)
W80-05114

**STOCHASTIC ANALYSIS OF ANNUAL RAINFALL AFFECTED BY URBANIZATION,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
A. R. Rao.
Journal of Applied Meteorology, Vol 19, No 1, p 41-52, January 1980. 5 Fig, 3 Tab, 7 Ref. OWRT-B-025-IND(6).

Descriptors: *Rainfall, *Stochastic processes, *Urbanization, Microclimatology, Urban hydrology, Precipitation(Atmospheric), Seasonal, Model studies, Cities, *Annual rainfall, *Stochastic analysis, Microclimate, Seasonality, Random variables, Integrated moving average, Standard error, Urban precipitation.

Investigators have shown that changes in microclimate were caused by large urban areas. Precipitation-related activity has been shown to be larger in and around urban areas than in the surrounding countryside. Seasonality of increased precipitation also has been investigated. This paper dealt with testing the significance of observed changes in the mean and in the trends of annual precipitation series of data from St. Louis, Missouri, and LaPorte, Indiana, and nearby stations. The annual rainfall series at LaPorte and St. Louis were found to be correlated. Thus, the traditional univariate and multivariate tests which were based on the assumption that the variates were independent random variables was not applicable to testing changes in the characteristics of annual precipitation data. Integrated moving average models of the annual precipitation data were used. The statistical significance of the observed changes in urban precipitation data was discussed, and a set of conclusions was presented. (Roberts-ISWS)
W80-05119

**EMPIRICALLY DERIVED PROBABILITY ESTIMATES OF DROUGHT PARAMETERS FOR WESTERN UNITED STATES BACK TO 1700 A.D.,**
M. P. Lawson, and D. Embry.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-190630, Price codes: A06 in paper copy, A01 in microfiche. Nebraska Water Resources Center, University of Nebraska, Lincoln Project Completion Report, September 30, 1979. 99 p, 28 Fig, 6 Tab, 32 Ref, 1 Append. OWRT A-055-NEB(1).

Descriptors: *Droughts, *Probability, *Stochastic processes, *Water shortage, Precipitation(Atmospheric), Weather patterns, Mathematical models, Model studies, Dendrochronology, Dating, History, Statistical methods, Climatic data, Climatology.

The runs method of analysis, a succession of similar events preceded and succeeded by different events, was used to compare theoretical probability drought models on a regional basis with presecular time series data. Data used dated back to 1700 A.D. and came from reconstructed moisture indices, Palmer Drought Severity Indices (P.D.S.I.), computed from tree-ring indices. Parameters used in computing P.D.S.I. include evapotranspiration, recharge, runoff, moisture loss, and precipitation. The P.D.S.I. can indicate drought severity, run-sum, as well as duration, run-length. Results for the 263 year period studied show droughts ranging from 4 to 11 continuous years. Major droughts of four or more years occurred during the periods of 1710-1720, 1720-1780, 1830-1870, the 1880's, and the 1930's. Maximum drought intensities ranged from a -6.825 to a -41.643 sum of negative P.D.S.I. values for droughts of 4 to 11 years. Maximum drought intensities were compared to their durations to compute ratios of average water deficiency. These regional ratios ranged from nearly 4:1 to less than 2:1. It appears that droughts in the Western U.S. begin with a slow deficit growing to a maximum deficit followed by a slow recovery. For a 200 year period the probability of maximum drought recurrence ranged from 1 to 83% with maximum intensity ranging from 1 to 10%. (Seigler-IPA)
W80-05247

**ENVIRONMENTAL CLIMATOLOGY OF LAKE SUPERIOR,**
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 2H.
W80-05284

**STOCHASTIC ANALYSIS OF ANNUAL RAINFALL AFFECTED BY URBANIZATION,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
A. R. Rao.
Journal of Applied Meteorology, Vol 19, No 1, p 41-52, January 1980. 5 Fig, 3 Tab, 7 Ref. OWRT B-025-IND(6).

Descriptors: *Urbanization, *Rainfall disposition, *Distribution patterns, *Weather modification, Rainfall, Local precipitation, Stochastic processes, LaPorte(IN), St. Louis(MO).

Several investigators have pointed out the changes in microclimate brought about by large urban areas. The paper deals with testing the significance of observed changes in the mean and the trends of the annual precipitation series from St. Louis, Missouri and LaPorte, Indiana and other stations in the vicinity of these stations. The annual precipitation data may not be assumed to be independent random variables because they may be correlated. For example, the annual rainfall series at LaPorte and St. Louis were found to be correlated. Consequently, the traditional univariate and multivariate tests which are based in the assumption that the variates are independent random variables may not be applicable to testing changes in the characteristics of annual precipitation data. As a result, Integrated Moving Average (IMA) models of the annual precipitation data are used in the study. The posterior distributions of the parameters of the IMA models were obtained by assuming locally uniform and independent prior distributions of the parameters. Significance tests based on these posterior distributions are used to determine the statistical significance of the observed changes in precipitation which are attributed to the effects of urbanization. The importance of model validation tests and their relationship to the inference are demonstrated by considering the IMA models of different orders. (Wiersma-Indiana)
W80-05331

**NORTON SOUND/CHUKCHI SEA OCEANOGRAPHIC PROCESSES (N-COP),**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 5A.
W80-05355

## 2C. Snow, Ice, and Frost

**RECONNAISSANCE SNOW SURVEYS OF THE NATIONAL PETROLEUM RESERVE IN ALASKA, APRIL 1977 AND APRIL-MAY 1978,**
Geological Survey, Anchorage, AK. Water Resources Div.
C. Sloan, D. Trabant, and W. Glude.
Available from: OFSS, Box 25425, Fed Ctr, Denver CO 80225. Price codes: $5.25 in paper copy, $3.50 in microfiche. Geological Survey open-file report 79-1342 (WRI), 1979. 31 p, 15 Fig, 3 Tab, 3 Ref.

Descriptors: *Snow surveys, *Evaluation, *Alaska, *Snow management, Sampling, Snowfall, Snow cover, Water equivalent, Snowpacks, Temperature, Remote sensing, *National Petroleum Reserve in Alaska.

Reconnaissance snow surveys of the NPRA (National Petroleum Reserve in Alaska) were made in April 1977 and April-May 1978 to ascertain general snow characteristics and distribution patterns. Thirty-nine sites in 1977 and forty-one sites in 1978 were sampled to determine snow depth, density, structure, and snow-soil interface temperature. In addition, snow surface wind indicators were examined over most of NPRA. In April and early May of two consecutive years, the snow cover in NPRA was thin, wind-packed, and virtually continuous. The depth and water equivalent of the snow generally increased with altitude and with distance from the coastal plain. Snow depth on tundra ranged from less than 0.20 m (meters) near the coast to more than 0.90 m in parts of the Brooks Range. Snow density was relatively high in areas where wind slab was developed throughout the snowpack, and lower where there was less wind slab. In 1977, the coastal plain showed the greatest wind slab development and higher densities, averaging 310 kg/cu m (kilograms per cubic meter) on tundra, while the mountains and foothills had less wind slab and lower densities, averaging 270 kg/cu m. In 1978, with more local variation, snow density on the coastal plain averaged 330 kg/cu m on tundra and averaged 310 kg/cu m in the mountains and foothills. Water equivalent of the snowpack in 1977 ranged from less than 0.10 m in the coastal areas to more than 0.25 m in the Brooks Range, and averaged nearly 0.12 m on tundra for the entire area. Water equivalent of the snowpack averaged more than 0.13 m in 1978. Snow-soil interface temperatures in 1977 ranged from about -20C on the coastal plain, where the snowpack was thin and ambient air temperatures were low, to about -5C in the mountains and foothills where the snowpack was thicker and ambient air temperatures higher. (Kosco-USGS)
W80-05294

## 2D. Evaporation and Transpiration

**ENERGY BUDGET AND MONTHLY EVAPORATION ESTIMATES FOR LAKE SUPERIOR, 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
W. M. Schertzer.
Journal of Great Lakes Research, Vol 4, No 3-4, p 320-330, December 1978. 6 Fig, 3 Tab, 38 Ref.

Descriptors: *Energy budget, *Evaporation, *Lake Superior, *Lake Ontario, Heat, Temperature, Parametric hydrology, Networks, Mass transfer, Boundary layers, *Evaporation estimates, *Thermal energy budget, Heat storage change, Network data, Water budget methods, Reflected global radiation, Long wave radiation, Emissivity.

Thermal energy budget components and monthly evaporation estimates were computed for Lake Superior, 1973. Temperature surveys were available from which monthly heat storage change could be evaluated. Other budget parameters were estimated partly from existing basin meteorological network data and partly from empirical relationships. Monthly evaporation estimates computed as a residual from the energy budget were compared to estimates given by the mass transfer and water budget methods. Agreement with the water budget results was within 1 cm for most months. Correspondence with the mass transfer values was less impressive. Large discrepancies occurred in summer situations when the boundary layer was stable and the mass transfer approach overestimated condensation. The thermal energy budget of Lake Superior was computed by assuming negligible contribution from such processes as heating from chemical and biological processes, heat conduction through the bottom, and transformation of kinetic energy to heat. (Roberts-ISWS)

W80-05282

## 2E. Streamflow and Runoff

**HYDROLOGIC CHARACTERISTICS OF AUSTRALIAN STREAMS,**
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
T. A. McMahon.
Report No 3/1979, (1979). 86 p, 21 Fig, 9 Tab, 37 Ref.

Descriptors: *Streamflow, *Discharge(Water), *Hydrology, *Australia, *Data collections, Analysis, Annual peak discharge, Flow, River flow, Watersheds(Basins), Runoff, Monthly, Annual flood, Variability, Mathematical models, Analytical techniques, Statistical methods, Time series analysis, Annual runoff.

This report compares the Australian scene with other continents. It considers the time series characteristics of both annual volumes and peak annual discharges, and it recommends for each annual volume series the type of stochastic model necessary to reproduce the annual flow characteristics. This report is divided into three main parts--analyses concerned with annual flows, monthly flows, and peak annual discharges. In the analyses, data from 166 annual records and 158 monthly flows were used; 172 station records were used in the peak discharge analyses. More than 90% of the station records are longer than 20 years; those with less data are for stations located in areas where longer records are not available. The important conclusions are: (1) Overall, the Australian streams are far more variable than similar streams in other continents. (2) The effect of catchment area on annual C sub V is ambiguous. (3) No one theoretical distribution can be considered to fit adequately the flow volume data of all streams. (4) Based on six tests, about 75% of the records are considered to be random. (5) For stochastic generation of annual flow volumes, a white noise model is adequate for 76% of streams. (6) Analysis of monthly flows shows that the carryover effect of monthly moisture diminishes to an insignificant level after several months. (7) Average 95% flow duration values exhibit up to two orders of magnitude difference among drainage basins. (8) Mean specific peak discharges were related by a power function to drainage areas. The value of the exponent is -0.44 which fits other Australian estimates but differs from values found in other countries. (9) Average values for drainage divisions of the index of variability of peak annual discharges varied from 0.18 in Tasmania to 0.65 for the arid zone. The median value was 0.46. (10) Approximately 17% of the 133 streams with continuous records showed dependence of peak annual discharges. (Humphreys-ISWS)
W80-05120

**THE EFFECT OF DATA INDEPENDENCE IN MODEL CALIBRATION AND MODEL TESTING,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W80-05141

**A NOTE ON CHANGES IN CHANNEL GEOMETRY AT TRIBUTARY JUNCTIONS,**
Hull Univ. (England). Dept. of Geography.
K. S. Richards.
Water Resources Research, Vol 16, No 1, p 241-244, February 1980. 3 Fig, 2 Tab, 19 Ref.

Descriptors: Geomorphology, *Streams, *Channels, *Width, *Model studies, Mathematical models, Rivers, Tributaries, Stochastic processes, Probability, Regression analysis, Drainage, Drainage patterns(Geologic), Hydrology, Hydraulics.

Evidence was presented to justify the assumption that channel width varies stochastically about an approximately constant mean width within a stream link of an alluvial channel. Adjustments of channel width occur predominantly at junctions, but Miller's simple model describing such changes is misleading, and an alternative was proposed whose implication is that channel width (and probably other channel dimensions) is a power function of link magnitude. It was suggested that an alternative to conventional hydraulic geometry is provided by the combination of a step function describing changes at junctions and a stochastic model of variation within individual links. (Sims-ISWS)
W80-05143

**COMPOSITE ROUGHNESS OF NATURAL CHANNELS,**
Dames and Moore, Bethesda, MD.
A. K. Motayed, and M. Krishnamurthy.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 70-78, 1978. 1 Fig, 1 Tab, 7 Ref, 2 Append.

Descriptors: *Natural streams, *Roughness coefficient, *Mannings equation, *Cross-sections, Roughness(Hydraulic), Channels, Variability, Equations, Analytical techniques, Analysis, Composite roughness, Mannings n.

The purpose of this investigation was to evaluate some of the existing formulas to compute the composite roughness with data from natural stream channels. In this analysis the roughness of subsections was calculated by assuming a logarithmic velocity distribution in each subsection. However, it is not yet fully established that logarithmic velocity distribution is valid during high stages of flows in river channels. In order to evaluate any such formula for composite roughness, it is therefore desirable to have the data necessary to compute the energy gradient in a reach, like water surface slopes and/or velocity contours. It was recommended that more data of natural channels during flood conditions be collected so that a better evaluation of formulas can be made. (See also W80-05159) (Humphreys-ISWS)
W80-05165

**HYDRAULICS OF FLOW IN THE KASKASKIA RIVER,**
Illinois State Water Survey, Urbana.
N. G. Bhowmik, and J. B. Stall.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 79-86, 1978. 5 Fig, 1 Tab, 5 Ref.

Descriptors: *River flow, *Flow characteristics, *Illinois, On-site investigations, Hydraulics, Flow, Velocity, Distribution patterns, On-site data collections, Analysis, Discharge(Water), Head loss, Roughness coefficient, *Kaskaskia River(IL), Isovels.

Hydraulics of flow were investigated at two reaches in the Kaskaskia River for low, medium, and bankful discharges. Analysis of cross-sectional shapes indicates that a trapezoidal shape can be used for straight reaches and a parabolic shape for the bends. In the bends, the maximum depths, up to 100% greater than the average depth, were located at a distance of about 25% of the width from the outside bank. The core of the high velocity remained near the center of the cross-section in the straight reaches for all flows. However, in the bend a shifting was observed. The nature of this shifting indicated the presence of a stronger secondary circulation at medium flow. The strength of the secondary circulation decreased when the discharge increased toward the bankful stages. The secondary circulation in the bends modified the velocity structure making the differential between the average velocity and the maximum-point velocities to be smaller than those present in the straight reaches. The total head loss over the whole length of the river decreased as the discharge increased. The unit discharge at various verticals was found to be proportional to the respective depths. (See also W80-05159) (Humphreys-ISWS)
W80-05166

**AN ANALYSIS OF TOTAL PHOSPHORUS TRANSPORT IN RIVER SYSTEMS,**
West Virginia Univ., Morgantown.
For primary bibliographic entry see Field 5B.
W80-05171

**INTRODUCTION TO NUMERICAL METHODS,**
Texas A and M Univ., College Station.
D. R. Basco.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 280-302, 1978. 16 Fig, 5 Ref.

Descriptors: *Mathematical models, *Hydraulics, *Streamflow, Model studies, Equations, Mathematics, Mathematical studies, Numerical analysis, Analytical techniques, Evaluation, Numerical methods.

Superficially, the finite-difference method is deceptively simple. Past emphasis on stability criteria and not on numerical accuracy has lulled the hydraulic engineer into believing that numbers generated by a 'calibrated' model are correct. Mathematically, an accuracy analysis is relatively complex. However, a recipe can be written for any scheme so that accuracy portraits (both amplitude and phase) can be easily computed. Although not exact, these portraits give insight into the proper grid and time spacings to employ, whether implicit schemes are worthwhile, and other factors to insure a desired accuracy in the computations. For simulation and modeling applications, these concepts will permit more physically realistic calibration and verification phases of the prototype. For computer-based research, these ideas must be understood to insure that the 'data' generated numerically is as accurate as that measured by instruments in physical experiments. (See also W80-01519) (Sims-ISWS)
W80-05184

**EXAMPLES OF PROPAGATION PROBLEMS,**
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
M. Amein.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 343-349, 1978. 4 Fig, 6 Ref.

Descriptors: *River flow, *Storm surge, *Model studies, Mathematical models, Computer models, Flow, Discharge(Water), Water levels, Hydrographs, Rivers, Bays, Hydraulics, Hydrology, Hydraulic propagation.

There are a number of practical propagation problems of concern to practicing engineers that can be correctly solved only by mathematical models requiring computers. Analytical solutions are not feasible, and hand-calculations would be time consuming. Among these are flood movements in rivers, dispersion of pollutants in estuaries and coastal waters, and computation of storm surge along the shores. Examples of propagation problems were presented. (See also W80-05159) (Sims-ISWS)
W80-05189

**WATER QUALITY MODELING USING HYDROCOMP SIMULATION PROGRAMMING (HSP),**
Hydrocomp, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 5B.
W80-05191

**NWS OPERATIONAL DYNAMIC WAVE MODEL,**
National Weather Service, Silver Spring, MD. Hydrologic Research Lab.
D. L. Fread.



V 13/16 AG 15 80 UMI

In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 455-464, 1978. 2 Fig.

Descriptors: *River forecasting, *Flood forecasting, *Mathematical models, Rivers, Floods, Water levels, Storage, Roughness(Hydraulic), Inflow, Dams, Locks, Hydrology, Dynamic wave models.

An operational hydrodynamic model (DWOPER) developed by the Hydrologic Research Laboratory of the National Weather Service is being placed in operational use by River Forecast Centers on a number of major river systems where storage routing methods are inadequate due to the effects of backwater, tides, and mild channel bottom slopes. The model is based on the complete one-dimensional St. Venant equations and belongs to the category of dynamic wave flood routing models. A weighted four-point nonlinear implicit finite difference scheme is used to obtain solutions to the St. Venant equations via a Newton-Raphson iterative technique. DWOPER has a number of features which make it applicable to a variety of natural river systems for real-time forecasting. It is designed to accommodate various boundary conditions and irregular cross-sections located at unequal distances along a single multiple-reach river or several such rivers having a dendritic configuration. It allows for roughness parameters to vary with location and stage or discharge. Temporally varying lateral inflows, wind effects, bridge effects, off-channel storage, and weir-flow channel bifurcations are included among its features. Applications of DWOPER to several large river systems have demonstrated its operational efficiency, accuracy, and utility. The model is currently being extended to account for effects of channel sinuosity, flood plains, sediment transport, and bank storage on unsteady flows in alluvial rivers. (See also W80-05159) (Sims-ISWS)
W80-05198

**EFFECTS OF EQUATION AVERAGING ON MODEL VERIFICATION,**
South Carolina Univ., Columbia. Dept. of Civil Engineering.
B. A. Benedict.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 483-491, 1978. 1 Tab, 17 Ref. USAF F08635-77-C-0237.

Descriptors: *Flow, *Diffusion, *Water quality, *Mathematical models, *Equations, Analytical techniques, Mathematics, Calibrations, Velocity, Streamflow, Hydrology, Pollutants, Path of pollutants, Equation averaging.

The concern over water quality has led to an increasing need for techniques to predict the behavior (movement, diffusion, and the like) of releases to a receiving water body. Analytical solutions to the diffusion equation are frequently used for these predictions. The basic equation of interest is the three-dimensional convective diffusion equation subjected to no-flux conditions at the air-water interface and at lateral and bottom boundaries. In arriving at a solution, one or more properties is averaged over one or more dimensions (including time) to obtain a tractable equation form. This paper was concerned with the important need to account for effects of these averaging processes when using data to verify these models. (See also W80-05159) (Sims-ISWS)
W80-05200

**PREDICTION OF RIVER STAGES,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
R-M. Li, G. O. Brown, and D. B. Simons.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 541-550, 1978. 6 Fig, 1 Tab, 1 Ref, 2 Append.

Descriptors: *Water levels, *Rivers, *Forecasting, *Model studies, *Mississippi, Mathematical models, Stage-discharge relations, Discharge(Water), Calibrations, On-site investigations, Alluvial channels, *Yazoo River(MS).

Accurate prediction of the river stage for a given discharge is one of the most important problems in fluvial hydraulics. Prediction of stage discharge is necessary for analysis of flood-damage mitigation, sediment transport, navigation, and water quality. River stage can be predicted either by statistical stage-discharge relationships or by using deterministic physical process models. Presently, there are no guidelines regarding the application of these two approaches. The purpose of this paper was to examine the frequency and magnitude of error associated with each model by applying each method to two case studies. One case involves a relatively stable reach of river, while the other is unstable. Both models are relatively accurate for the stable reach. However, the mathematical model that considers the physical processes of open channel flow and fluvial geomorphology is the only feasible approach to predict the response of an active river. In addition, a probabilistic prediction of the river stage by coupling the deterministic model with a stochastic discharge input was demonstrated. (See also W80-05159) (Humphreys-ISWS)
W80-05206

**TAXONOMY OF SOLUTIONS: UNSTEADY OPEN CHANNEL FLOW,**
Soil Conservation Service, Glenn Dale, MD. Engineering Div.
F. D. Theurer.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 591-598, 1978.

Descriptors: *Open channel flow, *Unsteady flow, *Analytical techniques, *Systematics, Mathematical models, Analysis, Algorithms, Classification, Methodology.

A taxonomy of solutions for unsteady open channel flow problems was offered which, hopefully, will lead to a comprehensive classification system and ultimately to a quantitative basis for evaluating various solutions. A valid taxonomic approach would bring order to a classification system in an orderly, not arbitrary, manner. This is done by addressing three basic questions to each specific solution scheme: (1) how good will the answer be, (2) how can the answer be obtained, and (3) how much is it going to cost. These three questions lead directly to the major areas of differentiation: (1) the math model, (2) the method of solution, and (3) the technique of computation. The math model is the analytic representation. The method of solution and technique of computations are distinct parts of methodology. The development of an unsteady open channel flow computer model for large scale field use is needed. Future studies will require: (1) the classification and selection of the important solutions to minimize the study effort, (2) the development of a means to relate the hydraulic and hydrologic properties of channel system and hydrographs to the responses so that the results can be reliably generalized for field applications, (3) the selection of the scope of the study to reflect field situations, (4) the development of a single comprehensive computer analysis model to minimize differences between programmers, (5) the execution and interpretation of test data to develop logical dependable data-directed techniques for an operational computer program, and (6) the development of an operational, comprehensive, data-directed, user-oriented, efficient, accurate, reliable, and optimized computer model for unsteady open channel flow problems. (See also W80-05159) (Humphreys-ISWS)
W80-05212

**SUBCRITICAL KINEMATIC STREAMFLOW,**
Tennessee Univ., Knoxville. Dept. of Civil Engineering.
D. E. Overton, and J. Bales.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 599-604, 1978. 5 Ref.

Descriptors: *Streamflow, *Subcritical flow, *Mathematical models, *Flood waves, Analytical techniques, Analysis, Equations, Discharge(Water), Open channel flow, Flood routing, Model studies, Kinematic flow equations.

Prediction of the behavior of a flood wave in a natural channel is essential in the design of channel improvements and flood control measures. The kinematic flow approximation has proven to be a very useful simplification in the determination of the movement of a flood wave down a channel and the prediction of any related changes in form or height of the wave. Integration of the momentum equation for kinematic flow in a wide rectangular channel for the cases of $b = 2.0$, $b = 2.5$, and $b = 3.0$ yields solutions for downstream flow depth at a given distance downstream, for a given set of physical conditions, and at a given point in time. Lateral inflow is independent of flow depth for the case of $b = 2.0$, and thus may be input into the solution as a step function. Momentum added by the lateral inflow was assumed to be negligible for the cases of $b = 2.5$ and $b = 3.0$. Thus a method of routing a flood wave through a natural channel under kinematic flow conditions was proposed. The only input required for the solution is the known physical information about the reach--the bed slope, Chezy C, width of the channel, and a single-valued rating curve--and the inflow hydrograph to the reach. This method of solution is also in the process of being made even more general by the numerical integration of the momentum equation. These solutions will have the added advantage of being applicable to any b value and may be used to verify the closed form analytical solutions of this study. (See also W80-05159) (Humphreys-ISWS)
W80-05213

**APPLICABILITY OF KINEMATIC AND DIFFUSION MODELS,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
V. M. Ponce, R-M. Li, and D. B. Simons.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 605-613, 1978. 4 Fig, 1 Tab, 5 Ref, 3 Append.

Descriptors: *Mathematical models, *Open channel flow, *Flood waves, *Celerity, Model studies, Diffusion, Overland flow, Waves(Water), Analytical techniques, Analysis, Flood routing, Kinematic wave model.

The applicability of the kinematic and diffusion models was assessed by comparing the propagation characteristics of sinusoidal perturbations to the steady uniform flow for the kinematic, diffusion, and dynamic models (the dynamic model is that based on the complete Saint Venant equations). The comparison allows the determination of inequality criteria that need to be satisfied if the kinematic or diffusion models are to simulate the physical phenomena within a prescribed accuracy. It was shown that bed slope and wave period (akin to wave duration in waves of shape other than sinusoidal) are the important physical characteristics in determining the applicability of the approximate models. Larger bed slopes or long wave periods will satisfy the inequality criteria. In practice, larger bed slopes are those of overland flow, and long wave periods are those corresponding to slow-rising flood waves. The diffusion model was shown to be applicable for a wider range of bed slopes and wave periods than the kinematic model. Where the two models break down, only the dynamic model will simulate the physical phenomena. The dynamic wave, however, was shown to have markedly strong dissipative tendencies. This conclusion has had ample corroboration in the literature. (See also W80-05159) (Humphreys-ISWS)

W80-05214

**THE NUMERICAL DISPERSION OF THE MUSKINGUM METHOD,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
V. M. Ponce, V. Yevjevich, and D. B. Simons.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 614-620, 1978. 2 Fig, 4 Ref, 2 Append.

Descriptors: *Flood routing, *Mathematical models, *Analytical techniques, Analysis, Dispersion, Numerical analysis, Equations, Mathematical studies, Kinematic wave equation.

It was the objective of this paper to further explore the nature of the numerical dispersion underlying the formulation of the Muskingum method. The findings reported should contribute to the increased understanding of the method and thus enhance its use and applicability for a wide range of flood routing problems. The analogy between the Muskingum formulation and the diffusion wave equation was demonstrated; both have the same limits of applicability. The applicability of the diffusion wave model has been established by Ponce and others on theoretical grounds. The numerical dispersion underlying the formulation of the Muskingum method was critically reviewed. A sensitivity analysis shows the calculated Muskingum discharge to be a bounded function of the Courant number and the cell Reynolds number. (See also W80-05159) (Humphreys-ISWS)
W80-05215

**THE STOCHASTIC VARIATION OF IN-STREAM VALUES IN RIVERS,**
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 5C.
W80-05217

**ANALYSIS OF SUB- AND SUPERCRITICAL DAM-BREAK FLOWS,**
Michigan State Univ., East Lansing. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W80-05223

**APPLICATION OF COSSARR MODEL IN CENTRAL JAVA,**
Engineering Consultants, Inc., Denver, CO.
For primary bibliographic entry see Field 2A.
W80-05226

**CONTROL OF UNSTEADY FREE-SURFACE FLOW WITH GATES,**
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
E. B. Wylie, and W. E. Bodley.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 767-774, 1978. 7 Fig, 6 Ref.

Descriptors: *Open channel flow, *Flow control, *Gates, Unsteady flow, Analytical techniques, Analysis, Reservoirs, Discharge(Water), Flow, Depth, Movement, Gate stroking.

The purpose of this paper was to show how the concept can be applied to a series of any number of pools separated by control gates. The application was illustrated for a series of three pools, separated by underflow gates, the series also originating and terminating in underflow gates, both with reservoir conditions on the other side. Channel dimensions and other properties were chosen to be representative of the California Aqueduct, for which empirical methods of control have been presented by Dewey and Madsen. Two typical demand changes were studied--flow initiation (0 to 3,520 cfs in 78 min), and flow arrest (6,000 cfs to 0 in 84.5 min). In each case, a linear change between the initial and the final demands was prescribed. The volume of water in each pool was maintained approximately constant throughout each demand change. The required motions of all control gates were determined, together with the transient water level variations that result from the imposed patterns of demand change. The results of all 'gate-stroking' calculations were confirmed by 'analysis.' (See also W77-10891 and W80-05159) (Humphreys-ISWS)
W80-05232

**THE EFFECT OF PRECIPITATION PATTERNS ON SURFACE RUNOFF,**
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 2A.
W80-05233

**LINEARIZED SUBHYDROGRAPHS URBAN RUNOFF MODEL,**
Akron Univ., OH. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W80-05234

**WATER QUALITY MODELING IN THE UPPER REACHES OF THE CHOWAN RIVER,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W80-05253

**DISSOLVED OXYGEN IN INTRAGRAVEL WATER OF THREE TRIBUTARIES TO REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA,**
Geological Survey, Helena, MT.
For primary bibliographic entry see Field 5B.
W80-05259

**USING ARTIFICIAL STREAMS TO EVALUATE PERTURBATION EFFECTS ON AUFWUCHS STRUCTURE AND FUNCTION,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 5A.
W80-05260

**WATER QUALITY PROJECTIONS: PREIMPOUNDMENT CASE STUDY,**
Maryland Univ., College Park, Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W80-05263

**FLOOD HAZARD IDENTIFICATION AND FLOOD PLAIN MANAGEMENT ON ALLUVIAL FANS,**
Army Engineer Div. North Pacific, Portland, OR.
L. M. Magura, and D. E. Wood.
Water Resources Bulletin, Vol 16, No 1, p 56-62, February 1980. 8 Fig, 6 Ref.

Descriptors: *Alluvial fans, *Flood plain insurance, *Southwest U.S., Management, Floods, Flood damage, Flood frequency, Flood waves, Flood flow, Erosion, Sediments, Design flood, Historic floods, Flash floods, Insurance, Hazards.

Recognition of the flood hazard that exists on alluvial fans has seriously lagged behind the recognition of other more conventional flood hazards such as those associated with most rivers. This delay in recognition was due, until recently, to a general lack of economic investment and development in these areas and a concomitant lack of historical alluvial fan flood damage. Dramatic recent events, such as Tropical Storm Kathleen, emphasized to the Federal Insurance Administration (FIA) the need for developing an appropriate methodology to identify flood hazard areas on alluvial fans. This paper presents the methodology now employed by FIA as well as flood plain management considerations that could reduce future flood related damage to communities developing in these areas. (Sims-ISWS)
W80-05264

**REGIONAL STOCHASTIC GENERATION OF STREAMFLOWS USING AN ARIMA (1,0,1) PROCESS AND DISAGGREGATION,**
Geological Survey, Harrisburg, PA. Water Resources Div.
J. T. Armbruster.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-300 945, Price codes: A04 in paper copy, A01 in microfiche.
Geological Survey Water-Resources Investigations 79-3, May 1979. 54 p, 26 Fig, 16 Tab, 24 Ref.

Descriptors: *Stochastic processes, *Streamflow, *Model studies, *Statistical models, *Flow characteristics, High flow, Low-flow, Natural flow, Correlation analysis, Frequency analysis, Regional analysis, Synthetic hydrology, Time series analysis, Pennsylvania, *Juniata River basin(Pa), *Autoregressive Integrated Moving Average(ARIMA), Dissaggregation.

An ARIMA (1,0,1) model was calibrated and used to generate long annual flow sequences at three sites in the Juniata River basin, Pennsylvania. The model preserves the mean, variance, and cross correlations of the observed station data. In addition, it has a desirable blend of both high and low frequency characteristics and therefore is capable of preserving the Hurst coefficient, h. The generated annual flows are disaggregated into monthly sequences using a modification of the Valencia-Schaake model. The low-flow frequency and flow duration characteristics of the generated monthly flows, with length equal to the historical data, compare favorably with the historical data. Once the models were verified, 100-year sequences were generated and analyzed for their low flow characteristics. One-, three- and six- month low-flow frequencies at recurrence intervals greater than 10 years are generally found to be lower than flow computed from the historical flows. A method is proposed for synthesizing flows at ungaged sites. (Kosco-USGS)
W80-05291

**HYDROLOGICAL FEATURES OF A CALIFORNIA COASTAL FEN,**
California Univ., Berkeley. Dept. of Forestry and Conservation.
For primary bibliographic entry see Field 2H.
W80-05310

**TRANSPLANTING AQUATIC BRYOPHYTES TO ASSESS RIVER POLLUTION,**
University Coll., Cardiff (Wales). Dept. of Botany.
For primary bibliographic entry see Field 5A.
W80-05311

## 2F. Groundwater

**COMPUTATIONALLY EFFICIENT POLYNOMIAL APPROXIMATIONS USED TO PROGRAM THE THEIS EQUATION,**
Wyoming Univ., Laramie. Dept. of Geology; and Wyoming Univ., Laramie. Water Resources Research Inst.
For primary bibliographic entry see Field 6A.
W80-05121

**PROGRAMMABLE HAND CALCULATOR PROGRAMS FOR PUMPING AND INJECTION WELLS: II--CONSTANT PUMPING (INJECTION) RATE, SINGLE FULLY PENETRATING WELL, SEMICONFINED AQUIFER,**
Missouri Univ. Rolla. Dept. of Geological Engineering.
For primary bibliographic entry see Field 6A.
W80-05122

**GROUND-WATER MODELING: AN OVERVIEW,**
GeoTrans, Corp., Reston, VA.
J. W. Mercer, and C. R. Faust.
Ground Water, Vol 18, No 2, p 108-115, March-April 1980. 4 Fig, 1 Tab, 8 Ref. EPA R-803713.

Descriptors: *Groundwater, *Aquifers, *Model studies, *Reviews, Mathematical models, Comput-

er models, Hydraulic models, Groundwater movement, Path of pollutants, Wells, Water wells, Pumping, Hydrology, Model usage, Modeling concepts.

Groundwater modeling is a tool that can help analyze many groundwater problems. Models are useful for reconnaissance studies preceding field investigations, for interpretive studies following the field program, and for predictive studies to estimate future field behavior. In addition to these applications, models are useful for studying various types of flow behavior by examining hypothetical aquifer problems. Before attempting such studies, however, one must be familiar with groundwater modeling concepts, model usage, and modeling limitations. (Sims-ISWS)
W80-05123

**INFLUENCE OF REGOLITH PROPERTIES ON MIGRATION OF SEPTIC TANK EFFLUENT,**
University of South Florida, Tampa. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W80-05124

**DETERMINATION OF AQUIFER PARAMETERS FROM STEP TESTS AND INTERMITTENT PUMPING DATA,**
Summers (W.K.) and Associates, Socorro, NM.
Y. K. Birsoy, and W. K. Summers.
Ground Water, Vol 18, No 2, p 137-146, March-April 1980. 13 Fig, 2 Tab, 7 Ref, 1 Append.

Descriptors: *Drawdown, *Pumping, *Theis equation, *Model studies, Mathematical models, Equations, Transmissivity, Storage, Recharge, Wells, Water wells, Groundwater, Groundwater movement, Aquifers, Test wells, Hydrology, Hydraulics, Hand calculator programs.

This note presented a technique used to evaluate drawdown and recovery data obtained during step-pumping tests or during several episodes of intermittent pumping. First, the simple general equation was presented that relates the usual variables (drawdown, transmissivity, storativity, etc.) to step-wise changes in discharge. (Intermittent pumping equates to a step with zero discharge.) Then it was shown how the equation provides a basis for determining transmissivity and storativity of the water-yielding rocks using nearly all the data simultaneously. Next it was discussed how departures of the data during conventional step-drawdown tests from the ideal provide other useful hydrogeologic information. Finally some examples were given from field experience. (Sims-ISWS)
W80-05125

**APPROXIMATION FOR SALT-WATER INTRUSION IN UNCONFINED COASTAL AQUIFER,**
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 2L.
W80-05126

**AQUIFER OCCURRENCE IN THE FORT PAYNE FORMATION,**
Oak Ridge National Lab., TN. Environmental Sciences Div.
M. S. Moran.
Ground Water, Vol 18, No 2, p 152-158, March-April 1980. 3 Fig, 2 Tab, 13 Ref. USGS 4061-02808.

Descriptors: *Aquifers, *Hydrogeology, *Water quality, *Groundwater, On-site investigations, Rocks, Geology, Geologic units, Chert, Sands, Gravels, Test wells, Sampling, Water chemistry, Chemicals, Petrology, Stratigraphy, Weathering, Fort Payne Formation.

The Fort Payne Formation of Early Mississippian (Osagean) age crops out over extensive areas of central Tennessee, south-central Kentucky, and northern Alabama. Specific formation lithologies are knwon to have been modified locally through weathering into an artesian aquifer along the Eastern Highland Rim of central Tennessee. The shallow aquifer can be divided into two parts; uppermost is a highly permeable chert gravel zone that is in hydraulic communication with a lower zone of interconnected solution cavities within bedrock. The gravel, at depths as great as 24.4 m (80 ft), fines upward into the clay-sized chert of the upper confining bed. The lower confining bed is the Chattanooga Shale of Late Devonian to Early Mississippian age. Field and petrographic studies of the Fort Payne Formation indicate that the aquifer has developed near the base of the unit. The chert gravel portion of the aquifer has developed from silicified dolowacke-stones of the Beaver Creek Limestone Member and from interbedded Fort Payne dolostones. The lower portion of the aquifer occurs within preferentially weathered, silicified and nonsilicified dolosiltstone. (Sims-ISWS)
W80-05127

**A COMPARATIVE STUDY OF NITRATE LEVELS AT THREE ADJACENT GROUNDWATER SOURCES IN A CHALK CATCHMENT AREA WEST OF LONDON,**
Thames Water Authority, Reading (England). Thames Conservancy Div.
E. M. Gray, and M. Morgan-Jones.
Ground Water, Vol 18, No 2, p 159-167, March-April 1980. 6 Fig, 3 Tab, 21 Ref.

Descriptors: *Groundwater, *Nitrates, *Hydrogeology, *Water chemistry, Boreholes, Borehole geophysics, On-site investigations, Water wells, Observation wells, Geology, Recharge, Infiltration, Chemicals, Pollutants, Path of pollutants, Fertilizers, Nutrients, Water resources, Water sources, *England.

A comparison of the concentrations of nitrate in three public supply borehole sources, which abstract water from the Chalk in a relatively local area, lead to a more detailed study of the possible causes of high nitrate values at one of the sources and the geological and recharge characteristics of all three. The local catchment area of the high nitrate source is actively fertilized, both by sludge spreading and the application of artificial fertilizers. The catchment areas of the other two groundwater sources are not subject to the same intensive agricultural activity. It was suggested that the differences in water quality between the three supplies are related to the variations in land use and the local hydrogeology. The study made it clear that due to local influences each source may have a unique hydrogeochemical character irrespective of being located in the same regional geological catchment area. More detailed investigations on the origins of the nitrate in the abstracted groundwaters are planned as a follow-up to this initial study. (Sims-ISWS)
W80-05128

**AN EVALUATION OF ILLINOIS LAWS AND REGULATIONS RELATED TO THE QUALITY OF GROUND WATER.**
Illinois Univ. at Urbana-Champaign.
For primary bibliographic entry see Field 6E.
W80-05154

**PERTURBATION SOLUTIONS FOR WATER-TABLE AQUIFERS,**
Geological Survey, Tacoma, WA.
E. A. Prych.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 106, No HY-4, p 603-608, April, 1980. 3 Fig, 3 Ref.

Descriptors: *Perturbation method, *Unsteady flow, *Ground water movement, *Water table aquifers, Equations, Numerical analysis, Transmissivity, Approximation method.

This paper describes a linearization procedure, based on a perturbation method, which can be used for solving the unsteady equation of motion for two-dimensional ground water flow in a water-table aquifer. This method retains the computationally efficient aspects of the method of specified transmissivities, yet partially accounts for the effect of the time-varying saturated thickness on the transmissivity. Consequently, numerical solutions of the perturbation equations can be more accurate than solutions of the equation with specified transmissivities. The only significant additional computation required with the perturbation method is the solution of one nonlinear steady-state problem. (Purdin-NWWA)
W80-05158

**CALIBRATION OF THE EDWARDS AQUIFER MODEL,**
Texas Dept. of Water Resources, Austin.
T. Knowles, and W. B. Klemt.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 94-100, 1978. 1 Fig.

Descriptors: *Model studies, *Aquifers, *Texas, *Groundwater, Aquifer management, Planning, Calibrations, Springs, Recharge, Computer models, Aquifer characteristics, Water levels, *Edwards Aquifer(TX).

The Edwards Aquifer Model was developed to determine the dependability of the Edwards (Balcones Fault Zone) aquifer as a water supply for the San Antonio, Texas, area. The model was developed to be a groundwater planning tool which would allow evaluation of the impacts of future pumpage on the aquifer. The model allows input of various sequences of recharge and pumpage and determines the resulting water levels and spring flows. The calibration procedure involved the adjusting of the initial estimates of the model's parameters until sufficiently accurate reproduction of water levels and spring flows were achieved. The period of record used in the calibration extended from 1947 through 1971. Most of the adjustments made during the calibration phase of the model development involved changing permeability values. This was due in large part to the confidence in the other values. The Edwards model has been used to evaluate several alternative development plans. Its results have been used in several studies, and it has proven to be an effective planning tool. The acceptance of the results provided by the model is due in large part to the effort applied in developing the data used during the calibration phase of its development. (See also W80-05159) (Humphreys-ISWS)
W80-05167

**STEADY STATE VS. TRANSIENT PARAMETER ESTIMATION IN GROUNDWATER SYSTEMS,**
Massachusetts Inst. of Tech., Cambridge.
J. L. Wilson, and M. Dettinger.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 112-119, 1978. 6 Ref, 1 Append. AID-NE-C-1291, OSP 85054.

Descriptors: *Aquifer systems, *Groundwater, *Model studies, Steady flow, Mathematical models, Analytical techniques, Analysis, Mathematical studies, Unsteady flow, Groundwater movement, Equations, Deterministic model, Parameter estimation.

The objective of this paper was to contrast the information content of field data from static observations to observations made during different levels of transient aquifer response. Linear predictive aquifer models based on First Order Analysis, accounting for system state and parametric uncertainty, were used in conjunction with the Kalman-Bucy Filter to predict future aquifer behavior and to obtain sequential parameter estimates. A simplification of these models was used for the estimation of parameters for steady state conditions. The analysis results demonstrated that static or slowly responding systems are relatively insensitive to the values of parameters, and consequently the parameters are difficult to estimate. For more rapidly responding and highly stressed systems the param-

eter sensitivity and the information content of measurements is significantly increased. (See also W80-05159) (Humphreys-ISWS)
W80-05168

**GROUNDWATER SIMULATION FOR KOEBERG POWER STATION,**
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Hydraulic Engineering.
For primary bibliographic entry see Field 2L.
W80-05174

**A HYBRID COMPUTER SYSTEM FOR GROUNDWATER MODELING,**
South Florida Water Management District, West Palm Beach.
G. Shih, and F. McVeigh.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 206-213, 1978. 2 Fig, 4 Ref.

Descriptors: *Groundwater, *Water management(Applied), *Analog models, Aquifers, Model studies, Hybrid computers, Resistance networks, Water utilization, Rainfall, Water wells, Canals, Instrumentation, Evapotranspiration, Calibrations, Hybrid models.

In this paper those aspects of analog simulation related to the South Florida Water Management District (SFWMD) model were discussed. The fluid flow of the aquifer is assumed to be described by the two-dimensional unsteady state equation. The study area was a water table aquifer; however, variations of saturated thickness were small in comparison to the total saturated thickness. The analog simulator was constructed in space-discretized form with a node representing a block area acceptable in space resolution. Since the system gives continuous response in time, the results may be obtained at any time desired. Calibration of the model was accomplished by subjective comparison of the model results and historical water table maps. Both initial condition setup and results after a period of operation are checked for validity. The analog model, with its simplicity in principle, offers a reasonable starting point in cases where there is scarce data. As a specific area simulation tool, the model is used in many different ways, accumulating experiences and knowledge of the aquifer system. At this point, it seems the simplicity in analog approach is becoming a limitation. While the analog model is still in active operation, in preparing for refinement of the Water Use Plan, a digital computer model has already been started. (See also W80-05159) (Humphreys-ISWS)
W80-05175

**THE OPTIMIZATION OF PUMPING OPERATIONS IN THE EL SOCORRO AQUIFER BY MATHEMATICAL MODELLING,**
National Water Authority of Jamaica (West Indies).
G. S. Shrivastava.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 214-221, 1978. 3 Fig, 1 Tab, 3 Ref, 2 Append.

Descriptors: *Aquifer systems, *Mathematical models, *Water management(Applied), Pumping, Optimization, Hydrogeology, Model studies, Saline water intrusion, Water levels, Groundwater, Aquifer characteristics, Foreign research, Analytical techniques, *Trinidad.

This study began with an investigation of the hydrogeology of the aquifer. The possible sources and mechanisms of intrusion were also examined. A digital simulation model of the aquifer was developed to study the effect of different monthly pumping schedules on the aquifer. During the development of the simulation model it became evident that the salt water intrusion problem had the characteristics of an optimization problem and that the processes of the aquifer were sequential in nature. A simple one-dimensional dynamic programming model was then developed and solved to obtain the desired pumping schedule. The optimum pumping schedule obtained by the application of digital simulation and dynamic programming techniques should prevent further deterioration of water quality and permit the aquifer to remain a significant source of water for the city of Port-of-Spain. The present mathematical models were developed on very limited data, and therefore refinement and extension of the models, as more data becomes available, is expected to considerably improve their effectiveness. (See also W80-05159) (Humphreys-ISWS)
W80-05176

**AN EXPERIMENTAL INVESTIGATION OF UPLIFT PRESSURES,**
Bechtel Incorp., San Francisco, CA.
For primary bibliographic entry see Field 8A.
W80-05196

**A STOCHASTIC-DYNAMIC APPROACH TO THE FOUNDATIONS OF SOLUTE TRANSPORT IN POROUS MEDIA,**
Mississippi Univ., University. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W80-05216

**A DIGITAL OVERLAY TECHNIQUE FOR EVALUATION OF POTENTIAL INFILTRATION AND RECHARGE,**
University of South Florida, Tampa. Coll. of Engineering.
For primary bibliographic entry see Field 4A.
W80-05261

**HYDRAULIC PROPERTIES OF A LIMESTONE-DOLOMITE AQUIFER NEAR MARION, NORTH-CENTRAL OHIO,**
Geological Survey, Columbus, OH. Water Resources Div.
S. E. Norris.
Ohio Department of Natural Resources Report of Investigations No 110, 1979. 23 p, 22 Fig, 4 Tab, 19 Ref.

Descriptors: *Hydraulic properties, *Limestones, *Aquifers, *Ohio, *Hydrogeology, Aquifer characteristics, Transmissivity, Water wells, Water yield, Pumping, Drawdown, Natural recharge, Leakage, Water supply, Waterfowl, *North-central Ohio, *Big Island Wildlife Area(Ohio).

Tests of a limestone-dolomite aquifer overlain by till at a site near Marion in north-central Ohio indicate strong aquifer heterogeneity, with hydraulic conductivity varying both laterally and vertically. The most conductive part of the aquifer is a 70-foot-thick section between depths of 80 and 150 feet, characterized by fissures and cavities. Transmissivity in the immediate vicinity of the pumped well is in the magnitude of 47,000 cu ft/d, falling to about 2,800 cu ft/d in the outer part of the cone of depression. An integrated value for transmissivity, determined from time-drawdown data by the straight-line semilogarithmic method, averaged about 3,600 cu ft/d; the coefficient of storage averaged about 10 to the minus 4th power. The effect of recharge by leakage from the glacial till was evident on the semilog graphs of time versus drawdown after 4,000 to 6,000 minutes of pumping. The hydraulic conductivity of the glacial till, based on an average regional saturated thickness of 35 feet, is the range of 1.0 x 10 to the minus 4th power to 3.4 x 10 to the minus 4th power feet per day. It is estimated that about half the quantity of 3,000 gal/min of ground water desired for a wildfowl preserve could be obtained from three existing production wells, but such withdrawal would be accompanied by significant drawdown over a wide area that might adversely effect the water supplies of many residents. (Kosco-USGS)
W80-05306

## 2G. Water In Soils

**ANALYSIS OF BOREHOLE INFILTRATION TESTS ABOVE THE WATER TABLE,**
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
D. B. Stephens, and S. P. Neuman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-188345, Price codes: A10 in paper copy, A01 in microfiche. Water Resources Research Center, University of Arizona Project Completion Report, March 1980. 216 p, 104 Fig, 4 Tab, 55 Ref, 7 Append. OWRT A-076-ARIZ(1).

Descriptors: *Infiltration, *Boreholes, *Model studies, Hydraulic models, Mathematical models, Soil water movement, Subsurface flow, Unsaturated flow, Water table, Finite element analysis, Hydraulics, Specific head, Soil mechanics, Flow characteristics.

Numerical models were used for a saturated-unsaturated analysis of the formulas used in analyzing results from constant head borehole infiltration tests of saturated hydraulic conductivities of unsaturated soils above the water table. A finite element model capable of solving free surface problems shows that in the case where unsaturated flow is not present, the formulas are reasonably accurate for a practical range of borehole conditions. Two different numerical models, a mixed explicit-implicit finite element model and a mixed explicit-implicit integrated finite difference model are used to simulate the effect of unsaturated flow on borehole infiltration under conditions approximating field conditions. While the models give approximately the same results, the integrated finite difference model is faster. Modeling results show that the classical free surface approach used to analyze infiltration results gives a distorted flow pattern for water in the soil. A significant percentage of the flow occurs under unsaturated conditions and only a finite region in the immediate area of the borehole is saturated. An improved design for borehole infiltration tests was developed along with more accurate interpretation methods. (Seigler-IPA)
W80-05108

**REGULATION OF SULFATE CONCENTRATIONS AND METHANOGENESIS IN SALT MARSH SOILS,**
Georgia Univ., Athens. Dept. of Microbiology.
For primary bibliographic entry see Field 2L.
W80-05134

**A SIMPLE NUMERICAL SOLUTION FOR THE VERTICAL FLOW EQUATION OF WATER THROUGH UNSATURATED SOILS,**
Technische Univ., Hanover (Germany, F.R.). Inst. fuer Bodenkunde.
J. Richter.
Soil Science, Vol 129, No 3, p 138-144, March 1980. 10 Fig, 1 Tab, 7 Ref.

Descriptors: *Soil water movement, *Numerical analysis, *Unsaturated flow, *Mathematical models, Percolation, Equations, Soil water, Soils, Computer programs, Hydraulic conductivity, Darcys law, Exponential function.

A simple numerical method to solve the vertical flow equation of water through unsaturated soils is presented. The method is based on the approximation K = K sub O X e to the alpha(psi) power and can be used for any range of soil moisture. The method uses the behavior of the exponential function in an integrated flux formula. The resulting numerical scheme is extremely easy to program and runs about as fast on microcomputers as implicit techniques do on large computers. Mass conservation is also excellent. (Visocky-ISWS)
W80-05135

**AN APPLICATION OF BRUTSAERT'S AND OPTIMIZATION TECHNIQUES TO THE NONLINEAR DIFFUSION EQUATION: THE INFLUENCE OF TAILING,**
Griffith Univ., Nathan (Australia). School of Aus-

tralian Environmental Studies.
J-Y. Parlange, and R. D. Braddock.
Soil Science, Vol 129, No 3, p 145-149, March 1980. 1 Tab, 11 Ref.

Descriptors: *Diffusion, *Soil water, *Soil water movement, *Model studies, Mathematical models, Equations, Mathematics, Analytical techniques, Optimization, Soil science, Diffusion equations.

A new analytical approximation to the solution of the diffusion equation is so accurate that it will be sufficient for most purposes. In addition, two simple iterations yield a profile that shows the influence of water movement at the initial moisture content. At that stage, the limit to the validity of the diffusion equation is reached, and further iterations are irrelevant. The results were illustrated for an exponential diffusivity. (Sims-ISWS)
W80-05136

**COMPARISON BETWEEN MEASURED AND SIMULATED PLANT WATER POTENTIAL DURING SOIL WATER EXTRACTION BY POTTED RYEGRASS,**
Louvain Univ. (Belgium). Lab. of Soil Physics.
J. Feyen, C. Belmans, and D. Hillel.
Soil Science, Vol 129, No 3, p 180-185, March 1980. 5 Fig, 23 Ref.

Descriptors: *Soil water, *Soil-water-plant relationships, *Evapotranspiration, *Model studies, Mathematical models, Laboratory tests, Evaporation, Grasses, Leaves, Wilting, Water-requirements, Agriculture, Soil science, Soil water extraction.

A combined simulation-experimentation study was conducted to monitor the simultaneously changing states of plant water and of soil water during a period of continuous transpiration by uniformly rooted ryegrass, grown in pots filled with sandy soil, under two levels of evaporative demand. The pattern of soil moisture extraction was measured by weighing and tensiometry, and that of plant water potential, by leaf psychrometry. A macroscopic-scale extraction model, previously published by the authors, was modified to account for the water-storage characteristics of the crop. Both the original and the modified versions of the model were found able to provide a realistic description of the diurnal fluctuations of plant water potential during the period prior to the onset of plant water stress, but they were less realistic in describing the decline of plant water potential during the dehydration and wilting phases. The rehydration of the crop from a stressed condition could be simulated realistically only by assigning a higher value of root resistance than during the initial extraction phase. (Sims-ISWS)
W80-05138

**WATER-MANOMETER TENSIOMETERS INSTALLED AND READ FROM THE LAND SURFACE,**
Geological Survey, Syosset, NY. Water Resources Div.
E. T. Oaksford.
Geotechnical Testing Journal, Vol 1, No 4, p 199-201, 1978. 6 Fig. American Society for Testing and Materials, Philadelphia, Pennsylvania.

Descriptors: *Manometers, *Tensiometers, *Instrumentation, *Soil moisture, Measurement, Artificial recharge, Infiltration rates, Recharge ponds, Evaluation, New York, *Long Island(NY), *Water-manometer tensiometers.

Soil-moisture tension has been measured beneath an artificial-recharge basin in Suffolk County, Long Island, N.Y. with water-manometer tensiometers that can be installed and read from the land surface. The manometer-tensiometer unit is buried at the desired depth, and soil-moisture tension is measured from land surface with a simple wire probe and electrical circuit that detect the level of water in the manometer. The water manometer is more sensitive than other common methods for determining unsaturated pressure head or soil-moisture tension over small ranges and is most helpful in situations where small changes in soil-moisture tension can reflect significant changes in hydraulic conductivity. Although the configuration may not be appropriate for installation at great depth (greater than 6 meters) or in extremely coarse or fine soils, it provides rapid, reliable measurement of soil-moisture tension. (Kosco-USGS)
W80-05307

## 2H. Lakes

**LIFE CYCLE, ECOLOGY, AND MANAGEMENT CONSIDERATIONS OF THE GREEN FILAMENTOUS ALGA, PITHOPHORA,**
Purdue Univ., Lafayette, IN. Water Resources Research Center.
For primary bibliographic entry see Field 5C.
W80-05101

**AN INTERACTIVE SIMULATION OF PUMPED STORAGE RESERVOIR SYSTEMS,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 4A.
W80-05142

**INVESTIGATIONS OF SPARGING AS A METHOD FOR PROMOTING COOLING POND HEAT TRANSFER,**
Argonne National Lab., IL. Atmospheric Physics Section.
B. B. Hicks.
Journal of Applied Meteorology, Vol 19, No 2, p 193-198, February 1980. 2 Fig, 1 Tab, 6 Ref, 1 Append.

Descriptors: *Heat transfer, *Cooling water, *Lakes, Ponds, Water temperature, Cooling, Thermal stratification, Subsurface investigations, Air-water interfaces, Sprinkling, Heat balance, *Sparging, *Cooling pond, Subsurface, Air bubbles, Aeration rates, Infrared thermometry, Sensible heat.

Destruction of the thin subsurface thermal boundary layer at an air-water interface can be accomplished by relatively low rates of aeration and can result in substantially improved thermal performance when water temperatures are high. The heating and saturating of rising air bubbles can also provide a significant improvement in overall thermal performance when water temperatures and aeration rates are sufficiently great. At 80C, destruction of the subsurface thermal boundary layer allows about 10% more heat transfer without significant increase in water temperature. At 20C, destruction of the subsurface thermal skin results in only a 3% improvement in thermal efficiency. The practical benefits of sparging as a heat transfer improvement mechanism are highest in the case of very hot water bodies associated with emergency cooling systems. (Roberts-ISWS)
W80-05152

**FIELD AND MODEL RESULTS FOR MULTIPORT DIFFUSER PLUME,**
Tennessee Valley Authority, Norris.
For primary bibliographic entry see Field 5B.
W80-05160

**HYDROTHERMAL ANALYSES USING COMPUTER MODELING AND FIELD STUDIES,**
Tennessee Valley Authority, Norris.
For primary bibliographic entry see Field 5A.
W80-05161

**MEASURING EFFLUENT PLUMES,**
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5A.
W80-05162

**A THREE DIMENSIONAL THERMAL PLUME MODEL,**
Cooper Union, New York.
For primary bibliographic entry see Field 5A.
W80-05163

**TURBID RESERVOIR STRATIFICATION MODELLING,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
S. Dhamotharan, H. G. Stefan, and F. R. Schiebe.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 156-163, 1978. 4 Fig, 2 Ref.

Descriptors: *Reservoirs, *Stratification, *Model studies, *Arkansas, Turbidity, Lakes, Suspended solids, Water temperature, Density stratification, Thermal stratification, Forecasting, On-site investigations, *Lake Chicot(AR).

A study to understand the dynamic characteristics of Lake Chicot, Arkansas, and to formulate a mathematical model to predict the effects of management alternatives on suspended loads is being carried out jointly by the University of Minnesota and the USDA Sedimentation Laboratory. The data taken so far show that the lake is a monomictic lake. In 1976 and 1977 the fall overturn of the lower lake started around the last week of September, after which period the lake stayed well mixed until about the first week of May when stratification started again. The upper lake remained stratified between the last week of May and the first week of September. Lake Chicot, with its shallow depth and large surface area, responds readily to the daily weather conditions. The mathematical simulation of the density stratification of Lake Chicot is therefore based on a method using energy principles and developed by Stefan and Ford. From the simulation results, the period of stratification as a function of weather conditions and heat exchange with the atmosphere was readily apparent, and also the periods of short-term or microstratification. The simulation also provides information on the daily equilibrium temperature which the water attempts to assume. (See also W75-04705 and W80-05159) (Humphreys-ISWS)
W80-05172

**MATHEMATICAL THERMAL MODEL FOR PUMPED-STORAGE,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
M. S. Dortch.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 492-499, 1978. 3 Fig, 6 Ref.

Descriptors: *Pumped storage, *Reservoirs, *Water temperature, *Model studies, Mathematical models, Hydroelectric power, Powerplants, Pumping, Mixing, Diffusion, Stratification, Temperature, Solar radiation, Lakes.

Kinzua Dam, completed in 1967 and operated by the U.S. Army Engineer District, Pittsburgh, is a pumped-storage hydropower (380 MW capacity) project located on the Allegheny River in northern Pennsylvania. Colder than desired release temperatures have been experienced at Kinzua Dam during the stratification season. A study was initiated during 1977 at the U.S. Army Engineer Waterways Experiment Station to determine the causes of the cooler than expected release temperatures and to evaluate various means of increasing the release temperatures to more closely match natural stream temperatures. A mathematical model is being used in the study to help evaluate corrective measures. This paper dealt with the calibration and verification of this model for pumped-storage operations at Kinzua Dam. The effect of pumped-storage on temperature is to decrease stratification by redistributing heat from the upper layers of the pool to the lower layers. This is evident by the large value of the diffusion coefficient that was required to simulate the temperatures of the bottom layers. The mathematical model, which was developed for computing the thermal budget of pumped-storage reservoirs, has a rather simple approach and provides reasonably good thermal predictions. (See also W80-05159) (Sims-ISWS)
W80-05201

**A GRAPHICAL COMPUTATION SYSTEM FOR THREE-DIMENSIONAL LAKE CIRCULATION AND CONTAMINANT DISPERSION,**
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 7C.
W80-05205

**AN ELECTRONIC MODEL OF HARBOR WAVES,**
Oklahoma Univ., Norman. Dept. of Civil Engineering.
M. M. Sternfeld, L. J. Pratt, and P. L. Monkmeyer.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 574-582, 1978. 6 Fig, 7 Ref.

Descriptors: *Waves(Water), *Harbors, *Analog models, *Model studies, Analytical techniques, Lakes, Theoretical analysis, Mathematical models, Finite element analysis, Instrumentation, *Port Washington(WI).

In an effort to uncover a less expensive and faster alternative to the physical model, an electronic model was described and subjected to preliminary testing in the present investigation. The theoretical background was developed, and the electronic analog was presented. Two separate tests of the model were described: the first simulating a uniform wave train propagating over a sloping bottom, and the second simulating a portion of the harbor of Port Washington, Wisconsin. Experimental and electronic wave envelopes were obtained by simulating a wave of period 1.8 sec. The discrepancy in phase and reflection coefficient between the two envelopes was less than 10%, a result typical of all the runs made. The major dissimilarity between the two profiles was in the variation of wave height over the sloping bottom. The electronic model predicts a decrease in height as shallow water is approached, a result contrary to both theory and experiment. This effect appears to be due to damping in the electronic circuit which seems to become significant when shallow, variable depth regions are being modeled. A resolution of this difficulty remains to be found. It is felt that with further minor modifications and refinements the model may become a relatively inexpensive alternative to the laboratory scale model. (See also W80-05159) (Humphreys-ISWS)
W80-05210

**PHOSPHORUS DYNAMICS IN A NORTH CAROLINA PIEDMONT RESERVOIR,**
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
E. J. Kuenzler, and L. E. Greer.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-188691, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Research Institute of the University of North Carolina, Raleigh, Report No UNC-WRRI-80-154, January 1980. 65 p, 14 Fig, 14 Tab, 104 Ref. OWRT A-102-NC(2).

Descriptors: *North Carolina, *Phosphorus, *Nutrients, *Nutrient removal, Lake stages, Eutrophication, Water sampling, Suspended solids, Lake sediments, Aquatic algae, Aquatic bacteria, Water temperature, Hypolimnion, Limnology, Epilimnion.

University Lake, a water-supply impoundment in the Piedmont Province of North Carolina, was sampled twice monthly for ten months to determine the patterns of phosphate uptake at different depths throughout the year. The lake is warm-monomictic or dimictic, has an area of 73 ha, a maximum depth of 9m, and an average depth of 3m. The lake is oxygenated at all depths in winter but beginning in March, thermal stratification prevents oxygen transport to the hypolimnion. Samples were taken with a Guzzler hand pump equipped with a plankton net to exclude zooplankton and macroinvertebrates and with a similarly equipped APHA stream sampler. Both chemical analyses and kinetic measurements were made. Filterable reactive phosphate concentrations were low with phosphate being half of the total P in winter but less than a quarter in the other seasons. Inorganic nitrogen concentrations in surface waters were also low. A range of phosphate rate coefficients was found from about 0.06% removal from surface water per minute in January to 40% per minute in June. Algal phosphate uptake was negligible throughout winter but became dominant in June. Results showed bacterial uptake exceeding algal uptake but measurement techniques for these values are questionable. In winter uptake was dominated by suspended sediments. Phosphorus was found to be the most probable major nutrient limiting phytoplankton growth in the lake. (Seigler-IPA)
W80-05244

**A FACTOR ANALYSIS OF ELEMENTAL ASSOCIATIONS IN THE SURFACE MICROLAYER OF LAKE MICHIGAN AND ITS FLUVIAL INPUTS,**
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
J. E. Mackin, R. M. Owen, and P. A. Meyers.
Journal of Geophysical Research, Vol 85, No C3, p 1563-1569, March 20, 1980. 5 Fig, 3 Tab, 52 Ref. NSG 04-7-158-44078.

Descriptors: *Lake Michigan, *Geochemistry, *Fluvial sediment, Sediments, Geology, Watersheds(Basins), Limnology, Lakes, Sampling, Statistical methods, Chemical analysis, Surface waters, Surface microlayer, Factor analysis, Sediment chemistry.

Elemental concentrations in surface microlayer and subsurface water samples from Lake Michigan and from its major fluvial sources were subjected to separate R mode factor analyses to define the geochemical phases and mechanisms which influence the composition of the surface microlayer. The associations revealed by these analyses indicate that the composition of fluvial microlayers is controlled by localized factors related to the geology of individual drainage basins, while open lake microlayers are influenced by broad scale physiochemical interactions. Depletions of both dissolved and particulate phase constituents in fluvial microlayers are attributed to upward diffusion of ions in sediment pore fluids and resuspension of bottom sediments. Enrichments of these constituents in open lake microlayers are due to organic complexation, biological uptake, and bubble flotation of fine-grained mineral particles. (Lee-ISWS)
W80-05254

**TIME SCALES IN WIND-DRIVEN LAKE CIRCULATIONS,**
National Weather Service, Silver Spring, MD. Systems Development Office.
M. A. Mohammed-Zaki.
Journal of Geophysical Research, Vol 85, No C3, p 1553-1562, March 20, 1980. 11 Fig, 14 Ref, 2 Append.

Descriptors: *Lakes, *Circulation, *Lake breezes, Turbulent flow, Eddies, Fluid mechanics, Winds, Limnology, Viscosity, Friction, Mathematical models, Model studies, *Lake circulation, Wind driven circulation, Linearized Ekman equation, Wind stress.

The effect of turbulent friction on transient three-dimensional wind-driven circulation in large lakes was studied. Horizontal friction was neglected, and vertical friction was modeled by a constant eddy viscosity. The linearized Ekman equations were used in a constant depth lake model which was assumed deep (of small Ekman number). High-frequency transients due to acoustic, internal, and surface gravity wave modes were eliminated through assumptions of incompressibility, homogeneity, and rigid lid surface, respectively. The initial value problem arising from a suddenly imposed wind stress on an initially quiescent lake was analytically solved, and significant time scales were identified. It was found that the manner in which transient currents adjust to temporal variations in wind stress depends not only on a lake's physical parameters but also on the wind stress spatial pattern. While the inertial period is always significant, the spin-up time is significant only when the wind stress has a nonzero curl. (Lee-ISWS)
W80-05255

**GROWTH INHIBITION OF HYDRILLA VERTICILLATA BY SELECTED LAKE SEDIMENT EXTRACTS,**
Southwest Florida Water Management District, Brooksville.
P. M. Dooris, and D. F. Martin.
Water Resources Bulletin, Vol 16, No 1, p 112-117, February 1980. 2 Fig, 1 Tab, 29 Ref.

Descriptors: *Plant growth, *Plant growth regulators, *Sediments, *Lakes, *Florida, Weed control, Aquatic weeds, Aquatic weed control, Inhibitors, Water chemistry, Chemical analysis, Laboratory tests, Biology, Limnology, Growth inhibitors.

Sediments were investigated from two Florida lakes that have not been infested with the submersed, perennial, noxious plant Hydrilla verticillata. Aqueous extracts of the peat-like sediments from these lakes were shown to inhibit the growth of Hydrilla verticillata in laboratory systems. The extracts have substantial concentrations of organic carbon and iron. The apparent molecular weight of the inhibitory fraction is between 2,000 and 10,000, based upon ultrafiltration studies. Hydrilla growth was about 35% relative to control for a partially purified fraction at a level of 0.4 ppm organic carbon. Growth was measured as change in biomass (wet and dry) over a one-week period. The inhibitory material was highly fluorescent, dark brown, and inhibitory activity was lost after passage over an anion-exchange column (Cellex-D). (Sims-ISWS)
W80-05258

**WATER QUALITY PROJECTIONS: PREIMPOUNDMENT CASE STUDY,**
Maryland Univ., College Park, Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W80-05263

**LAKE SUPERIOR IN THE 21ST CENTURY,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 6B.
W80-05265

**THE FISH COMMUNITY OF LAKE SUPERIOR,**
Ontario Ministry of Natural Resources, Maple. Fish and Wildlife Research Branch.
For primary bibliographic entry see Field 5C.
W80-05266

**BENTHIC DIVERSITY AND SUBSTRATE-FAUNA ASSOCIATIONS IN LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
R. Dermott.
Journal of Great Lakes Research, Vol 4, No 3-4, p 505-512, December 1978. 3 Fig, 3 Tab, 37 Ref.

Descriptors: *Lake Superior, *Benthos, *Biomass, *Limnology, Sediments, Zinc, On-site investigations, Aquatic life, Invertebrates, Nematodes, Spatial distribution, Oligochaetes, Benthic fauna, Surveys, Lakes, *Whitefish Bay(MI), *Duluth Basin, Diversity weight.

The benthic community of Lake Superior was dominated by Pontoporeia affinis, Stylodrilus heringianus, the Enchytraeidae, and Pisidium conventus. Both total abundance and the low benthic diversity displayed an increase from west to east. The biomass diversity H' weight ranged from 0.29 in the Duluth Basin to 1.22 near Whitefish Bay. Associations between the sediment variables and dominant species present indicated that the effects of depth, percent sand, and mean particle size were prominent. The Sphaeriidae, Chironomini, Pontoporeia, and Rhyacodrilus were negatively associat-

ed with depth, while the Nematoda, Chironomini, and Rhyacodrilus were negatively associated with sand. Stylodrilus and Sphaeriidae were negatively associated with the sediment zinc levels. (Humphreys-ISWS)
W80-05267

**PHYTOPLANKTON-ZOOPLANKTON ASSOCIATIONS IN LAKE SUPERIOR: A STATISTICAL APPROACH,**
Canada Centre for Inland Waters, Burlington (Ontario).
M. Munawar, and J. B. Wilson.
Journal of Great Lakes Research, Vol 4, No 3-4, p 497-504, December 1978. 1 Fig, 5 Tab, 25 Ref.

Descriptors: *Lake Superior, *Phytoplankton, *Zooplankton, *Limnology, *Data processing, Lakes, Analytical techniques, Analysis, Statistical methods, Sampling, Correlation analysis, Data collections, Crustaceans, Aquatic life, Biomass, Water temperature.

Very little is known about the multiple phytoplankton-zooplankton links in complex food chains. Lake Superior, with a zooplankton population dominated by herbivores, and a phytoplankton community consisting mainly of nannoplankton, is a unique environment for the study of plankton associations. Appropriate statistical techniques, including partial correlations, canonical correlations, and factor analysis, were used to analyze phytoplankton-zooplankton data collected concurrently on Lake Superior during 1973. The multivariate methods revealed more detailed, but less easily interpretable, patterns than did the partial correlations. Over the entire sampling season, canonical correlation and factor analysis produced three significant roots and three multivariate factors, respectively. Temperature was a strong first factor and a root variable during the stratified period. The proposed statistical approaches might serve as powerful tools to explore the apparent relationships between trophic levels. The application of such analyses to comparisons of plankton associations in lakes of varying trophy may prove a useful avenue of research. (Humphreys-ISWS)
W80-05268

**CRUSTACEAN ZOOPLANKTON OF LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
N. H. F. Watson, and J. B. Wilson.
Journal of Great Lakes Research, Vol 4, No 3-4, p 481-496, December 1978. 9 Fig, 3 Tab, 25 Ref.

Descriptors: *Lake Superior, *Zooplankton, *Crustaceans, *Aquatic animals, Lakes, Surveys, Limnology, On-site investigations, Sampling, Copepods, Biomass, Spatial distribution, Data collections, Calanoids.

Six lakewide surveys were carried out on Lake Superior between May and November of 1973. The zooplankton population was found to be dominated by calanoids, and total abundance was generally low in comparison with the lower Great Lakes. Little variation was seen in total numbers/cu m through the sampling season, but total biomass increased fivefold between May and September. The lake appeared to support a permanent year-round lakewide community composed of Diacyclops bicuspidatus thomasi and the larger calanoid species. This community was augmented annually by a succession of summer forms which developed initially inshore and then spread to various degrees into the offshore waters. The zooplankton data were fitted to the fifteen zones defined by previous authors. This procedure showed the zooplankton community to be quite heterogeneous with greatest abundances being found in the inshore zones. Seasonal cycles of both numbers and biomass varied widely, but zone patterns could easily be grouped by general geographic area. The use of zone averages revealed a strong correlation between zooplankton biomass and surface water temperature. Cluster analysis was used to define independently regions of similar species composition. This procedure revealed that the zooplankton community was relatively homogeneous throughout the lake in the spring. Local clusters appeared in many inshore areas during the early summer, and by early fall the zooplankton community distribution was heterogeneous. Homogeneous conditions returned quickly with the late fall turnover. Most of the inshore regions occurred adjacent to areas of probable land-use effects. The life histories of selected major species were examined in cases where sampling and identification procedures permitted their analysis. (Humphreys-ISWS)
W80-05269

**STATISTICAL EVALUATION OF THE RELATIONSHIPS BETWEEN PHYTOPLANKTON BIOMASS, CHLOROPHYLL A, AND PRIMARY PRODUCTION IN LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
A. El-Shaarawi, and M. Munawar.
Journal of Great Lakes Research, Vol 4, No 3-4, p 443-455, December 1978. 5 Fig, 9 Tab, 17 Ref.

Descriptors: *Lake Superior, *Phytoplankton, *Chlorophyll, *Primary productivity, Statistical methods, Biomass, Spatial distribution, Temporal distribution, Regression analysis, Data processing, Analytical techniques, Lakes, Limnology.

Phytoplankton biomass, chlorophyll a, and primary production data collected during 1973 from Lake Superior were statistically analyzed using different regression techniques. The pattern of the spatial and temporal variabilities displayed by these parameters was determined. The analysis resulted in dividing the lake into three regions based on phytoplankton biomass and chlorophyll a, whereas two regions were found for primary production. The relationship between the biomass and chlorophyll a was highly significant, but the degree of significance varied by season. The variability in the chlorophyll a concentration was found closely related to the changes in the relative abundance of various taxonomic groups of phytoplankton. (Sims-ISWS)
W80-05270

**PHYTOPLANKTON OF LAKE SUPERIOR 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
M. Munawar, and I. F. Munawar.
Journal of Great Lakes Research, Vol 4, No 3-4, p 415-442, December 1978. 18 Fig, 8 Tab, 47 Ref.

Descriptors: *Phytoplankton, *Lake Superior, *Great Lakes, Biomass, Spatial distribution, Temperature, Water temperature, Diatoms, Dinoflagellates, Nannoplankton, Plankton, Aquatic microorganisms, Primary productivity, Nutrients, Lakes, Limnology, Cyanophyta, Chlorophyta, Cryptomonads, Chrysomonads, Phytoflagellates, Species composition.

The horizontal and vertical distribution of Lake Superior phytoplankton was studied from May to November/December 1973 at approximately monthly intervals from 34 stations distributed over the entire lake. Taxonomic identification and enumeration were carried out using the inverted microscope Utermoehl technique. The mean phytoplankton biomass showed a homogeneous distribution with very low biomass concentration across the lake (0.1-0.2 g/cu m). It did not show any inshore/offshore differentiation, although relatively high values were observed in the western end. On a lakewide basis the seasonal composition was dominated by the phytoflagellates (53%) and diatoms (38%), with the bluegreens and greens contributing the least. Among the phytoflagellates, Cryptophyceae (26%), Chrysophyceae (21%), and Dinophyceae (5%) were the main contributors. Lake Superior is characterized by a large number of species. Approximately 285 taxa were identified, the majority of which have not been reported before in Lake Superior or the other Laurentian Great Lakes. The offshore and open lake waters possessed large numbers of common species usually found in oligotrophic environments. However, the western end contained a limited number of common species, dominated by species of Melosira which are often associated with eutrophication. The offshore species succession revealed dominance of species usually found in oligotrophic waters. Several rare species were also identified. Some of them like Stelexmonas dichotoma Lackey and Chrysolykos planctonicus Mack were indicative of a cold-stenothermal oligotrophic environment. Vertical profiles exhibited three types of biomass-temperature relationships, one of which was the presence of a subthermocline maximum which appeared to be photosynthetically active. On the basis of biomass and species composition, Lake Superior was classified as an ultraoligotrophic environment similar to the deep, large, oligotrophic, boreal lakes. Lake Superior results, once again, emphasize the significance of phytoflagellates and nannoplankton in the algal dynamics of the Laurentian Great Lakes and demand the application of the standard Utermoehl technique in all phycological investigations. (Sims-ISWS)
W80-05271

**SURFACE DISTRIBUTIONS OF AEROBIC HETEROTROPHS AND THEIR RELATIONSHIPS TO TEMPERATURE AND NUTRIENTS IN LAKE SUPERIOR DURING 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
S. S. Rao.
Journal of Great Lakes Research, Vol 4, No 3-4, p 408-414, December 1978. 4 Fig, 2 Tab, 27 Ref.

Descriptors: *Lake Superior, *Aerobic bacteria, *Water pollution, Bacteria, Oligotrophy, Lakes, Distribution, Sampling, Analysis, Surfaces, Water quality, Nutrients, Water temperature, On-site investigations, Phosphorus, Ammonia, Spatial distribution, Nitrites, Nitrates, Heterotrophs.

The distribution and densities of aerobic heterotrophic bacteria were measured in the surface layers of Lake Superior from May to November 1973, and correlated with temperature and certain nutrient levels. On a lakewide basis bacterial densities were closely related to temperature, increasing from June until September, after which their levels started to decline. A similar relationship was noted in the nearshore areas of the lake until the September-October period, after which heterotroph densities increased despite the decrease in temperature (4C) in November. The importance of psychrophilic bacterial species in the nearshore areas of the lake and the relationships between heterotrophs and nutrients in the lake were discussed. (Humphreys-ISWS)
W80-05272

**CHLORINATED ORGANIC RESIDUES IN FISH, WATER, AND PRECIPITATION FROM THE VICINITY OF ISLE ROYALE, LAKE SUPERIOR,**
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
W. R. Swain.
Journal of Great Lakes Research, Vol 4, No 3-4, p 398-407, December 1978. 2 Fig, 5 Tab, 11 Ref.

Descriptors: *Lake Superior, *Water pollution, *Air pollution, *Pesticide residues, Polychlorinated biphenyls, Fish, Precipitation(Atmospheric), Rainfall, Lakes, Organic compounds, DDE, Sampling, On-site investigations, Analysis, DDT, Data collections, Pesticides.

Studies of persistent organic contaminants for the Upper Lakes Reference Group of the International Joint Commission indicated increased levels of organic contamination in the flesh of fish taken from the vicinity of Isle Royale on Lake Superior. Significant increases in levels of organic residues in Lake Superior fish near Isle Royale were observed in lean lake trout, Salvelinus namaycush, and in fat lake trout, Salvelinus namaycush siscowet. Siskiwit Lake, a deep cold lake on Isle Royale, well removed from the direct influences of man, was selected as a control site for studies on Lake Superior. Values for several organic residues in the flesh of fish from Siskiwit Lake were significantly higher than corresponding fish from Lake Superior. Polychlorinated biphenyls were nearly double the Lake Superior mean value, and p, p-DDE showed a more than tenfold increase in Siskiwit

Lake. These findings lead to a preliminary study of the transport of polychlorinated biphenyl compounds in atmospheric precipitation. Data from the Isle Royale area were compared with metropolitan sites and with those of other investigators. (Humphreys-ISWS)
W80-05273

**ORGANOCHLORINE SUBSTANCES IN LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
W. M. J. Strachan, and G. E. Glass.
Journal of Great Lakes Research, Vol 4, No 3-4, p 389-397, December 1978. 2 Tab, 44 Ref.

Descriptors: *Lake Superior, *Water quality, *Reviews, *Pesticides, Chlorinated hydrocarbon pesticides, Polychlorinated biphenyls, DDT, Dieldrin, Endrin, Sediments, Fish, Organochlorine pesticides, Chlordane.

Published and governmental reports on Lake Superior were examined for accounts of the presence of polychlorinated biphenyls (PCBs), organochlorine pesticides (OCs), and other material in environmental samples of water, sediments, and fish. PCBs, DDT residues, and dieldrin were most often examined for and observed, although levels of hetachlor epoxide, chlordane, lindane, endrin, and a-BHC were determined infrequently and several chlorobenzenes and chloronorbornenes were found. Levels of PCBs and DDT often exceed International Joint Commission water quality objectives. An inability to compare most of the data was a major problem in assessing the data. (Humphreys-ISWS)
W80-05274

**A COPPER ANOMALY IN WESTERN LAKE SUPERIOR,**
Canada Center for Inland Waters, Burlington (Ontario).
N. D. Warry.
Journal of Great Lakes Research, Vol 4, No 3-4, p 386-388, December 1978. 2 Fig, 2 Tab, 17 Ref.

Descriptors: *Lake Superior, *Water quality, *Metals, Copper, Hydrogen ion concentration, Lakes, Surveys, On-site investigations, Data collections, Iron, Manganese, Nickel, Analysis, Methodology.

Elevated concentrations of soluble copper up to five times greater than 'normal' mean lakewide concentrations have been observed in the Duluth arm of Lake Superior in early spring. The concentration increase is attributable to abnormally high loading in the low pH spring meltwater coupled with a lack of water movement in this part of the lake. Unfortunately, it was not possible to determine what class of soluble metal was being detected. That is, it could not be determined whether the copper was present as a free metal ion, or was bound as some labile or nonlabile metal complex, or was present as an adsorbed species. As a result, no statement regarding the potential toxicity of the increased metal concentration can be made. (Humphreys-ISWS)
W80-05275

**CHEMISTRY OF LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
R. R. Weiler.
Journal of Great Lakes Research, Vol 4, No 3-4, p 370-385, December 1978. 9 Fig, 7 Tab, 23 Ref.

Descriptors: *Water quality, *Lake Superior, *Water chemistry, Spatial distribution, Temporal distribution, On-site investigations, Lakes, Alkalinity, Manganese, Conductivity, Metals, Ions, Copper, Zinc, Cobalt, Lead, Iron, Mercury, Cadmium, Chromium, Water temperature, Nutrients, Chlorides, Silica, Sampling, Phosphorus, Surveys, Hydrogen ion concentration, Analysis, Data collections, Nitrates, Sodium, Calcium, Magnesium, Sulfates, Potassium, Dissolved oxygen, *Trace metals.

This paper presents information on the distribution, both spatial and temporal, of major ions, trace metals, and nutrients in Lake Superior. The main source of information was the six cruises undertaken by the Canada Centre for Inland Waters in 1973, but earlier data from other sources were used to trace changes back to before 1900. It was concluded that essentially: (1) The concentration of major ions has remained constant since the beginning of the century. The quality and scarcity of data for the trace metals do not permit deductions to be made. Of the nutrients, only nitrate shows a clear trend, increasing at about 3 micrograms/L per year. (2) The waters of the lake are quite uniform both vertically and horizontally, except for the western end near Duluth. Well-defined seasonal cycles exist only for nitrates, silica, pH, and oxygen in the surface layer. These cycles are linked to the seasonal increase in plankton biomass. The geological, physical, and chemical factors that determine the chemistry of the lake were discussed, and it was concluded that Kramer's model of 1964 fits the data on major ion chemistry. In this model, the concentration of all ions, except chloride and sulfate, is determined by mixing rainwater with waters from tributaries that have reached equilibrium with minerals found in the surrounding rocks. The large discrepancies between calculated outflows and inflows of chloride, silica, total phosphorus, nitrogen, and dissolved solids, as well as the differences in the budgets calculated by different workers, suggest that a closer look has to be taken at the data and the calculations. The other possibility is that the recent concentrations in the lake are increasing slowly. (Humphreys-ISWS)
W80-05276

**MAJOR ION LOADINGS TO LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
M. E. Thompson.
Journal of Great Lakes Research, Vol 4, No 3-4, p 361-369, December 1978. 2 Fig, 6 Tab, 8 Ref.

Descriptors: *Water quality, *Hydrologic budget, *Ions, *Lake Superior, Hydrology, Precipitation(Atmospheric), Chemical precipitation, Forecasting, Cations, Anions, Calcium, Magnesium, Bicarbonates, Sulfates, Chlorides, Water chemistry, Data collections, Chemical reactions, Analytical techniques.

A method of predicting tributary loadings of major ions to Lake Superior was described, making use of the water budget and chemical composition of Lake Superior, and of data on the chemistry of atmospheric precipitation on or around the lake. Predicted tributary loading were compared with tributary water chemistry, and the basic assumptions of the procedure were confirmed: chemical weathering in the basin is the principal source of calcium, magnesium, and bicarbonate ions to the lake; the atmosphere is the major source of sulfate and chloride to the lake and to its basin. Both the predicted loadings and the river chemistry loadings estimates indicate an excess loading, mainly atmospheric in origin, of chloride and sulfate, but because the lake volume is so great, increases in concentrations of these ions in the open waters of the lake will not be detectable for several decades. (Humphreys-ISWS)
W80-05277

**TURBIDITY DISPERSION IN LAKE SUPERIOR THROUGH USE OF LANDSAT DATA,**
Minnesota Univ.-Duluth. Dept. of Physics.
V. Shuter, K. Stortz, G. Oman, and M. Sydor.
Journal of Great Lakes Research, Vol 4, No 3-4, p 359-360, December 1978. 2 Fig, 5 Ref.

Descriptors: *Lake Superior, *Turbidity, *Dispersion, *Remote sensing, Satellites(Artificial), Sediments, Suspended solids, Clays, Diffusivity, Winds, Mixing, Currents(Water), Water circulation, Lakes, Limnology.

Consecutive Landsat images of a red clay turbidity plume due to runoff from Nemadji River, Wisconsin, were used in computation of the horizontal eddy diffusivity for Lake Superior. Dispersion of turbid areas ranging from 2.5-5.4 km in diameter and having average velocities of 0.4 cm/sec-6.1 cm/sec were investigated. The coefficient for horizontal eddy diffusivity ranged from 0.6-1.5 sq m/sec. (Sims-ISWS)
W80-05278

**WATER TRANSPARENCY OF LAKE SUPERIOR IN 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
W. M. Schertzer, F. C. Elder, and J. Jerome.
Journal of Great Lakes Research, Vol 4, No 3-4, p 350-358, December 1978. 5 Fig, 2 Tab, 26 Ref.

Descriptors: *Lake Superior, *Turbidity, *Surveys, *Sampling, On-site investigations, Phytoplankton, Light, Water temperature, Depth, Chlorophyll, Lakes, Limnology, Extinction coefficients, Water transparency.

Measurements relating to water transparency were made at roughly monthly intervals during the period May through November 1973 on Lake Superior. Spectrometer data augmented with extensive transmissometer and Secchi disc observations at a grid of stations over the lake were used to compute mean vertical extinction coefficients and photic depth for photosynthetically active radiation in the wavelength band 400-500 nm. These permitted description of the temporal and spatial variability of photic conditions throughout the major photosynthetic production period. The data showed spatial and temporal variability in water transparency between areas and, for some zones, considerable departures from the lakewide mean were evident. The mean vertical extinction ranged from approximately 0.15 to 0.25/m for the majority of zones, and relatively good correspondence was observed with seasonal changes in chlorophyll a concentration. Considerably lower rates of light attenuation occurred in the deeper midlake zones. Photic zone depth in these areas characteristically ranged from 20 to 30 meters. Reduced water transparency generally predominated along coastal areas in the proximity of Duluth, Thunder Bay, the southwest red clay portions of the lake, Apostle Islands, Nipigon-Black Bay, Marathon, and Whitefish Bay. Photic zone depths in these areas were primarily less than 20 meters throughout the photosynthetic production period. In the vicinity of Duluth, mean photic depth values of less than 10 meters were observed with extreme minimums approaching 2 meters. (Sims-ISWS)
W80-05279

**SIMULATION OF WATER CIRCULATIONS AND CHLORIDE TRANSPORTS IN LAKE SUPERIOR FOR SUMMER 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
D. C. L. Lam.
Journal of Great Lakes Research, Vol 4, No 3-4, p 343-349, December 1978. 5 Fig, 16 Ref.

Descriptors: *Circulation, *Water circulation, *Chlorides, *Lake Superior, *Model studies, Mathematical models, Simulation analysis, Hydrodynamics, Mixing, Stratification, Currents(Water), Hypolimnion, Epilimnion, Pollutants, Path of pollutants, Dispersion, Upwelling, Lakes, Limnology, Chloride transport.

The mean water circulations of Lake Superior during June to September 1973, were obtained by hydrodynamical modeling. The time interval covered most of the stratification period during which the temperature data were adequately collected and analyzed. The computed results showed reasonable agreement with observed current meter readings. In particular, the generally counterclockwise circulation and some features of the Keweenaw current were obtained in the results. A computed map showing the frequent upwelling and downwelling zones was also given. These zones were often referred to in the description of the physical, chemical, and biological regimes of the lake. The computed currents provided adequate description of the advective transports during the period. By parameterizing the turbulent diffusion in an advection-diffusion model, it was

shown that the formulation proposed in previous studies appears to be also applicable for simulating the chloride transport in Lake Superior. Based on these studies, the mixing times of conservative materials were estimated to be about 2 to 3 years for Lake Superior depending on the location of the source. (Sims-ISWS)
W80-05280

**WATER BUDGETS FOR LAKE SUPERIOR AND WHITEFISH BAY,**
Canada Centre for Inland Waters, Burlington (Ontario).
E. B. Bennett.
Journal of Great Lakes Research, Vol 4, No 3-4, p 331-342, December 1978. 3 Fig, 5 Tab, 20 Ref.

Descriptors: *Hydrologic budget, *Precipitation(Atmospheric), *Watersheds(Basins), *Lake Superior, Rainfall, Evaporation, Hydrologic cycle, Hydrology, Water storage, Lakes, Bays, Water loss, Monthly, Data collections, Phosphorus, Networks, Runoff, Surface runoff, *Whitefish Bay(MI).

Average monthly and annual water budgets were presented for Lake Superior and for Whitefish Bay, through which water flows from the lake to discharge in St. Mary's River. Annual over-lake rainfall, estimated from monthly maps, is 93% of precipitation rate on land but accounts for 51.5% of the total input of water. Land drainage to the lake calculated from river discharge data is 7.5% higher than a previous estimate based on surface runoff. Estimates of evaporation from the lake surface, determined as the residual in the water balance, differ significantly from estimates derived by mass transfer techniques during early summer when the over-lake atmospheric boundary layer is very stable. Evaporation is the smallest term in the annual water budget, but is more than half of St. Mary's River discharge, the largest term. Diversions of water to Lake Superior have increased the mean rate of St. Mary's River discharge from 2136 to 2297 cu m/s. Relatively high rainfall and land drainage to Whitefish Bay result in reduction of flow from the main body of Lake Superior, and in principle cause a significant difference between the concentration of a material in the water of Lake Superior and that of water entering St. Mary's River. Lake Superior has the longest flushing time (177 years) among the Great Lakes, and thus concentrations of conservative materials in the lake are most sensitive to changes in loading rates and require the longest time to adjust to a change in loading. (Humphreys-ISWS)
W80-05281

**ENERGY BUDGET AND MONTHLY EVAPORATION ESTIMATES FOR LAKE SUPERIOR, 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2D.
W80-05282

**CHARACTERISTICS OF THE THERMAL REGIME OF LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
E. B. Bennett.
Journal of Great Lakes Research, Vol 4, No 3-4, p 310-319, December 1978. 10 Fig, 1 Tab, 9 Ref.

Descriptors: *Lake Superior, *Great Lakes, *Water temperature, *Heat, Lakes, Temperature, Water circulation, Stratification, Stability, Upwelling, Dissolved oxygen, Surveys, Sampling, Limnology, Thermal regime.

Among the Great Lakes, Lake Superior has the lowest summer surface temperature and mean annual lake temperature, but has the highest spring and annual heat incomes per unit area. These characteristics are associated with the large depth and width of the lake, and with relatively long periods of extensive vertical mixing during spring and fall, and short intervening periods of stratification. The thermal regime has a strong observed influence on seasonal cycles in the vertical and horizontal distribution of currents, and in turn is influenced by coastal and midlake upwelling. (Sims-ISWS)
W80-05283

**ENVIRONMENTAL CLIMATOLOGY OF LAKE SUPERIOR,**
Atmospheric Environment Service, Downsview (Ontario).
D. W. Phillips.
Journal of Great Lakes Research, Vol 4, No 3-4, p 288-309, December 1978. 16 Fig, 7 Tab, 17 Ref.

Descriptors: *Lake Superior, *Great Lakes, *Climatology, *Lakes, Topography, Water temperature, Stability, Precipitation(Atmospheric), Winds, Waves(Water), Fog, Humidity, Ice cover, Air pollution, Climates, Weather, Meteorology, Limnology.

Among the variety of local controls which shape the climate of the Lake Superior region, the presence of the lake itself with its large surface area and great depth is by far the most important. Climatological influences are not just confined to the immediate vicinity of the lake but are spread downwind in all directions over the entire Great Lakes system--intensifying storms, moderating temperatures, augmenting and suppressing precipitation and cloud cover, enhancing wind speeds, generating waves, etc. The annual range of surface water temperature rarely exceeds 10C. Differences in temperature between the surface water and the over-riding air are very high and positive from May through August. Consequently, occurrences of fog, pollution stagnation, and condensation are frequent during the warming period. Light, persistent winds are much less frequent over Lake Superior compared to land stations, and there is a predominant local circulation from lake to land during daytime and a reversed flow at night. The effect of the climate on the potential quality of the air-water environment is much in evidence. Even upper air stations have registered the importance of Lake Superior on mixing heights and ven lation coefficients. In recent years it has become evident that atmospheric input of sulfate to the Great Lakes is now believed to be a significant portion of the sulfate pollution of the lakes. (Sims-ISWS)
W80-05284

**SEDIMENTATION RATES AND A SEDIMENT BUDGET FOR LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
A. L. W. Kemp, C. I. Dell, and N. S. Harper.
Journal of Great Lakes Research, Vol 4, No 3-4, p 276-287, December 1978. 4 Fig, 4 Tab, 36 Ref.

Descriptors: *Sedimentation rates, *Lake Superior, *Wisconsin, *Sediment distribution, Lakes, Deposition(Sediments), Sediments, On-site investigations, Bank erosion, Pollen, Rivers, Surveys, Sampling, Clays, Sands, Iron, Silts, Beach erosion, Analysis, Sediment budget, Organic carbon, Ambrosia horizon.

Present-day sedimentation rates were determined at ten offshore locations, representative of the depositional basins in Lake Superior. Sedimentation rates were calculated by averaging the weight of sediment deposited above the Ambrosia pollen horizon, dated at 1890. The rates are variable ranging from a low of 25 g/sq m/yr to a maximum value of 780 g/sq m/yr. Sedimentation rates were related to the proximity of terrestrial source, circulation patterns, and bottom topography. The highest rates were found at locations closest to the edges of the depositional basins and at the base of steep-sided troughs. The present-day sedimentation rates were proportional to the postglacial sedimentation rates at almost every locality and were half the value of the postglacial rates. A total of 6.029 million tons of fine-grained sediment is annually deposited in the lake. Erosion of the red clay bluffs of Wisconsin is the major sediment source accounting for up to 58% of the external input. Rivers contribute 30% of the external sediment load. It is calculated that the Duluth basin is the repository of 37% of the total present-day natural sediment loading to the lake. (Humphreys-ISWS)
W80-05285

**SEDIMENTS OF LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
R. L. Thomas, and C. I. Dell.
Journal of Great Lakes Research, Vol 4, No 3-4, p 264-275, December 1978. 9 Fig, 2 Tab, 37 Ref.

Descriptors: *Lake Superior, *Sediments, *Surveys, Sampling, Geology, Glacial sediments, Bottom sediments, Bathymetry, Particle size, Chemistry, Carbon, Data processing, Lakes, Sedimentology, Limnology, Lake sediments.

Samples (406) were taken of the surficial 3 cm of sediment from Lake Superior in 1973. A description of these samples together with the interpretation of continuous echosounding records resulted in a description of the surface sediment distribution which was interpreted in the light of the glacial and postglacial evolution of the lake basin. Samples were analyzed for grain size, Eh, pH, organic and inorganic carbon. These parameters were described and related to the modern depositional environment. Eh, pH, and organic carbon reflected the current nature of the lake as being oxic and oligotrophic with low primary productivity. Grain size parameters showed distributional trends related to water depth indicating progradation from coarse to fine materials as a function of increasing water depth. (Sims-ISWS)
W80-05286

**LAKE SUPERIOR BASIN AND ITS DEVELOPMENT,**
Canada Centre for Inland Waters, Burlington (Ontario).
D. H. Matheson, and M. Munawar.
Journal of Great Lakes Research, Vol 4, No 3-4, p 249-263, December 1978. 8 Fig, 1 Tab, 47 Ref.

Descriptors: *Lake Superior, *Great Lakes, *Lakes, *Reviews, Water quality, Water temperature, Physical properties, Water balance, Hydrology, Circulation, Water circulation, Water chemistry, Biological communities, Pollutants, Water pollution, Nutrients, Sediments, Trace elements, Metals, Asbestos, Precipitation(Atmospheric), Limnology.

Lake Superior is unique in having the largest surface area of any freshwater lake in the world; in volume it is second only to Lake Baikal. Its location on the edge of the Canadian Shield, in a rugged land and in a northern climate, has delayed and limited the cultural development of the basin. Natural loadings to the lake are small since the bedrock is resistant to weathering; man-made pollution is slight because of the low population density in the watershed. The lake surface occupies more than one-third of the basin area with the result that direct precipitation on the lake surface is the major source of water input. Atmospheric transport is considered to be one of the most important sources of chemical loadings, the ultimate origin of which may be quite remote from the watershed. The present state of our knowledge about the Lake Superior basin was reviewed from several points of view which include the historical, geological, physical, chemical, and biological aspects. It was apparent that the influence of man-made pollution has not yet affected the lakewide water quality, and most of the lake remains in a largely unaltered oligotrophic condition. In 1972 the two bordering countries, Canada and the United States, entered into an agreement aimed at preserving this major resource. During 1976 the International Joint Commission received a report which described the baseline water quality conditions of the lake. This report provided much of the information on which managerial practices in the basin will be based during the next decade. (Sims-ISWS)
W80-05287

**THE INFLUENCE OF THICK FLOATING VEGETATION (WATER HYACINTH: EICHHORNIA CRASSIPES) ON THE PHYSICO-CHEMICAL ENVIRONMENT OF A FRESH WATER WETLAND,**
Bhagalpur Univ. (India). Ecology Research Lab.
For primary bibliographic entry see Field 2I.

W80-05309

**HYDROLOGICAL FEATURES OF A CALIFORNIA COASTAL FEN,**
California Univ., Berkeley. Dept. of Forestry and Conservation.
D. C. Erman, K. B. Roby, and M. Eames.
Great Basin Naturalist, Vol 37, No 1, p 57-66, March, 1977. 5 Fig, 3 Tab, 16 Ref.

Descriptors: *Fen, *California, *Hydrologic aspects, Wetlands, Peat, Marshes, Sediments, Magnesium, Calcium, Streamflow.

A 38.6 ha fen on the California coast depends on six streams for its supply of flowing, mineral-rich water. About 25% of the water is supplied by surface streams that had average concentrations of 0.15-0.32 meq Ca(2+)/l and 0.25-0.47 meq Mg(2+)/l. During the dry summer period, oxygen concentrations and pH were lower in the central fen area than in the margins. Water flow near the margins supports high 02, pH, and cation content levels. The fen ranges from 4 to over 11 m in depth, with the thickest peat layer being made up of very liquid, unconsolidated peat. In one year, an estimated 19.3 metric tons of suspended sediments entered the fen, which was equivalent to a 42 kg/ha loss from the total watershed. (Steiner-Mass)
W80-05310

**PHOTOSYNTHETICALLY ACTIVE RADIATION IN A STAND OF PHRAGMITES COMMUNIS TRIN. IV. STOCHASTIC MODEL,**
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
J. P. Ondok.
Photosynthetica, Vol 9, No 2, p 201-210, 1975. 7 Fig, 1 Tab, 1 Append.

Descriptors: *Marsh plants, *Model studies, *Energy conversion, Wetlands, Photosynthesis, Light intensity, Plant physiology, Primary productivity.

The model inputs are the hourly sums of photosynthetically active radiation (PhAR). Its daily and seasonal course is simulated using distributions derived from previously recorded data. Two submodels (one for direct and the other for diffuse sky radiation) are introduced, each containing three compartments: PhAR intercepted by foliage, PhAR intercepted by water below the reed canopy, and PhAR reflected to the atmosphere by both the foliage and water. The daily course of radiant energy content in these compartments is simulated: the result is the regime of PhAR in a reed stand during the whole growing season. The course of radiation reaching the top of a stand canopy can be fitted to a smooth curve only under clear sky conditions. In natural weather conditions, this course is irregular and involves rapid changes due to clouds. These changes have a stochastic character: by relating them to a time scale, empirical distributions of irradiance are obtained. The actual daily course of irradiance may be simulated on the basis of distributions fitted to the empirical distributions by the generating process. In the model, hourly values of irradiance were chosen as the first approximation to the reality, but the model is not restricted to this selected scale and may be easily applied to any other time scale. (Steiner-Mass)
W80-05314

**PETROGRAPHY AND PALEOECOLOGY OF HOLOCENE PEATS FROM THE OKEFENOKEE SWAMP-MARSH COMPLEX OF GEORGIA,**
Southern Illinois Univ., Carbondale. Dept. of Geology.
A. D. Cohen.
Journal of Sedimentary Petrology, Vol 44, No 3, p 716-726, September, 1974. 12 Fig, 18 Ref.

Descriptors: *Swamps, *Georgia, *History, Wetlands, Marshes, Marsh plants, Peat, Palynology, Burnings.

The Okefenokee Swamp, a paludal region of over 400,000 acres is developed upon a terrace which was formerly a Pleistocene marine lagoon separated from the open ocean by a long barrier island. The lack of any salt tolerant plants in the peat at the contact with the sandy substrate suggests that some considerable length of time occurred after withdrawal of the sea and before production of the first peats. Also, the fact that the first-formed peat in all cases was a highly oxidized deposit containing residual siliceous material indicates that some thickness of previously deposited peat may have been destroyed before the onset of modern peat deposition. Palaeobotanical analyses of cores from the three largest marshes reveal that these areas have not changed greatly in vegetational and depositional environment from the beginning. In addition, the present positions of these marshes seems to be controlled by the positions or pre-peat topographic lows. Their vegetational continuity to the present day is probably related to: (1) a continuous, uniform rise in water levels, (2) the common occurrence of fires in the Okefenokee, and (3) the consistently greater depths of peat in these regions. (Steiner-Mass)
W80-05315

**THE LITTORAL VEGETATION OF NORDBYTJERNET, A SMALL LAKE IN SOUTH-EAST NORWAY,**
Oslo Univ. (Norway). Dept. of Marine Biology and Limnology.
For primary bibliographic entry see Field 2I.
W80-05318

## 2I. Water In Plants

**THE OCCURRENCE OF BRYOPHYTES ON BRITISH SALTMARSHES,**
Cambridge Univ. (England). Botany School.
P. Adam.
Journal of Bryology, Vol 9, p 265-274, 1976. 1 Fig, 2 Tab, 32 Ref.

Descriptors: *Mosses, *Britain, *Salt marshes, Wetlands, Marshes, Distribution patterns, Habitat, Salt marshes, Bryophytes.

The widespread occurrence of British saltmarsh bryophytes is reported with a discussion of the communities in which the bryophytes are most frequently found. These communities are more common on marshes on the west coast of Britain. Differences between moss assemblages on slat marshes in England, Wales, and Scotland are emphasized and the greater range of habitat preference demonstrated by Grimmia maritima in Scotland is commented upon. (Steiner-Mass)
W80-05308

**THE INFLUENCE OF THICK FLOATING VEGETATION (WATER HYACINTH: EICHHORNIA CRASSIPES) ON THE PHYSICO-CHEMICAL ENVIRONMENT OF A FRESH WATER WETLAND,**
Bhagalpur Univ. (India). Ecology Research Lab.
D. N. Rai, and J. D. Munshi.
Hydrobiologia, Vol 62, No 1, p 65-69, 1979. 5 Fig, 1 Tab, 8 Ref.

Descriptors: *Vegetation effects, *Water hyacinth, *Microenvironment, Wetlands, Marsh plants, Aquatic plants, Floating plants, Dissolved oxygen, Water temperature, Freshwater marshes.

Dissolved 02 was generally lower, dissolved carbon dioxide higher, pH lower, and temperature fluctuations lower under areas covered by water hyacinth than in open water areas. The extent of the difference was found to be dependent upon the time of day and season. Due to extreme hypercarbic and hypoxic conditions, mostly air breathers and supplemental air breathers were found living under the hyacinth mat. Reasons for the higher carbon dioxide and lower 02 levels were the high anaerobic decomposition rate of the mat's detritus, increased respiratory activities of organisms, and decreased photosynthesis rate due to the shadowing effect of Eichhornia crops over the water surface. (Steiner-Mass)
W80-05309

**TRANSPLANTING AQUATIC BRYOPHYTES TO ASSESS RIVER POLLUTION,**
University Coll., Cardiff (Wales). Dept. of Botany.
For primary bibliographic entry see Field 5A.
W80-05311

**FUNGI ASSOCIATED WITH THE ROOTS OF RED MANGROVE, RHIZOPHORA MANGLE,**
Hawaii Univ., Honolulu. Dept. of Botany.
B. K. H. Lee, and G. E. Baker.
Mycologia, Vol 65, p 894-906, 1973. 1 Fig, 4 Tab, 33 Ref.

Descriptors: *Mangrove swamps, *Soil fungi, *Rhizosphere, Wetlands, Swamps, Fungi, Marine fungi, Distribution patterns, Soil microorganisms, Root zone, Hawaii.

The microbial communities of root-free soil, the rhizosphere, and the rhizoplane of a red mangrove swamp in Hawaii were studied. There was a pronounced rhizosphere effect with greater numbers of bacteria, actinomycetes, and fungi occurring at all salinity levels in the rhizosphere soil than in the root-free soil at corresponding salinity levels. Primarily the microfungi isolated from the rhizoplane were known root-surface or root-tissue fungi. In the rhizosphere community, Fungi Imperfecti contributed 87.9% of the species. Phycomycetes and Ascomycetes comprised the balance. No Phycomycetes were recovered from the rhizoplane. Ascomycetes were isolated in the rhizosphere, the rhizoplane, live roots above the tidal line, and dead roots below the tidal line. Basidiomycetes and Myxomycetes were found only on live prop roots above the tidal line. Eight species of Fungi Imperfecti were predominant in the rhizosphere and rhizoplane. (Steiner-Mass)
W80-05312

**AIRBORNE MULTISPECTRAL SURVEY OF INTERTIDAL VEGETATION IN ALASKA,**
Environmental Research Inst. of Michigan, Ann Arbor.
F. C. Polcyn, N. E. G. Roller, S. Zimmerman, and J. Gnagy.
International Symposium of Remote Sensing of the Environment, Vol 12, p 1091-1102, 1978. 9 Fig, 3 Tab.

Descriptors: *Intertidal zone, *Marine algae, *Remote sensing, Aerial photography, Distribution patterns, Spatial distribution, Alaska, Surveys, Shores.

Digital analysis was performed on a set of multispectral data collected by a low-flying aircraft at study sites in the Gulf of Alaska for the purpose of mapping intertidal algal communities. Both supervised and unsupervised pattern recognition procedures were employed. Results show that it is possible to separate a scene into (1) broad spatial zones corresponding to vegetation density for areas of low percent cover and (2) algae types according to their taxonomic division (green, blue green, red, etc.) for areas with high levels of percent cover. Clustering techniques were found to be the most effective way to extract training signatures. A minimum of four spectral bands is needed to achieve the recognition performance levels demonstrated in this study. Two channels in the visible (green and red), one in the near-infrared region ('APPROX.' 1.0 m) and one in the thermal region were found most useful. (Steiner-Mass)
W80-05313

**SIMPLE MODELS FOR CALCULATING EVAPORATION FROM DRY AND WET TUNDRA SURFACES,**
Atmospheric Environment Service, Downsview (Ontario). Hydrometeorological and Environmental Impact Div.
R. B. Stewart, and W. R. Rouse.
Arctic and Alpine Research, Vol 8, No 3, p 263-274, 1976. 8 Fig, 1 Tab, 21 Ref.

Descriptors: *Evaporation, *Arctic, *Tundra, Energy budget, Model studies, Solar radiation, Air temperature, Canada, Hudson Bay lowlands.



V 13/16 AG 15 80 UMI

Energy-budget calculations and equilibrium evaporation estimates from a well-drained lichen-dominated raised beach ridge and a wet sedge meadow in the Hudson Bay lowlands are presented. Energy-budget calculations reveal that on the average 54 and 66% of the daily net radiation are utilized in the evaporative process over a ridge and sedge meadow surface, respectively. For the ridge, half-hourly and daily values of evaporation were approximated closely by equilibrium estimates, while for the sedge meadow, close approximation was achieved by a model where the ratio of actual to equilibrium evaporation equals 1.26. A simple model, expressed in terms of incoming solar radiation and air temperature is developed for each surface from the comparison of actual and equilibrium evaporation. Tests of the models at different locations indicate that the actual evaporation can be estimated on a daily basis within 10% for dry upland and saturated sedge meadow surfaces. (Steiner-Mass)
W80-05316

**VEGETATIONAL DEVELOPMENT AND THE EFFECT OF GEESE ON VEGETATION AT LA PEROUSE BAY, MANITOBA,**
Toronto Univ. (Ontario). Dept. of Botany.
R. L. Jefferies, A. Jensen, and K. F. Abraham.
Canadian Journal of Botany, Vol 57, No 13, p 1439-1450, 1979. 6 Fig, 4 Tab, 40 Ref.

Descriptors: *Salt marshes, *Marsh plants, *Snow geese, Wetlands, Wildlife, Marshes, Arctic, Grasses, Waterfowl, Vegetation regrowth, Distribution patterns, Damages, Vegetation effects, Plant growth, Canada, La Perouse Bay(Manitoba).

The unconsolidated, water saturated sediments of the La Perouse Bay salt marshes are colonized by Hippuris tetraphylla, Puccinellia phryganodes, and Carex subspathacea. These sediments undergo frost heave, and on elevated mounds, Elymus arenarius and Salix brachycarpa become established. Where drainage is impeded in the upper marsh, relatively high salinities occur and species such as Salicornia europaea and Triglochin maritima are present. A population of 10,000-20,000 lesser snow geese feed in summer on P. phryganodes, C. subspathacea, Potentilla egedei, and E. Arenarius. The birds strip the shallow turf of P. phryganodes in low-lying areas between clumps of willow. This terracing of the surface creates depressions which become filled with water and ice. The role of geese in producing these ponds in the upper levels of salt marshes in the actic does not appear to have been reported previously. The ponds are subsequently colonized by Carex aquatilis and Triglochin maritima. The salt marsh gives way to extensive freshwater marsh dominated by species of Salix, Eriophorum augustifolium, Calamagrostis neglecta, and Dupontia fisheri. (Steiner-Mass)
W80-05317

**THE LITTORAL VEGETATION OF NORDBYTJERNET, A SMALL LAKE IN SOUTH-EAST NORWAY,**
Oslo Univ. (Norway). Dept. of Marine Biology and Limnology.
D. Hongve.
Norwegian Journal of Botany, Vol 22, p 83-97, 1975. 8 Fig, 4 Tab, 17 Ref.

Descriptors: *Littoral, *Aquatic plants, *Lakes, Rooted aquatic plants, Distribution patterns, Water levels, Norway, Nordbytjernet(Norway).

In the epilittoral, the two main phytocoenoses were dominated by Carex rostrata and Calamagrostis canescens. Among the hydrophytes, three life forms dominated; namely, helophytes, nymphaeids, and elodeids. The elodeid vegetation was especially rich. The hydrophyte species were found to intermingle, and no clearly defined zones of different life forms with increasing depth were discernible, probably because of the relatively steep slope of the shore inhabited by the plants. (Steiner-Mass)
W80-05318

**GROWTH, CHLOROPHYLL AND MINERAL NUTRIENT STUDIES ON PHALARIS ARUNDINACEAE L. IN THREE SCOTTISH LOCHS,**
Dundee Univ. (Scotland). Dept. of Biological Sciences.
Y. B. Ho.
Hydrobiologia, Vol 53, No 1, p 33-43, 1979. 11 Fig, 6 Tab, 15 Ref.

Descriptors: *Mineral requirements, *Chlorophyll, *Plant growth, *Marsh plants, Wetlands, Marshes, Temporal distribution, Carbon, Nitrogen, Phosphorus, Potassium, Sodium, Calcium, Magnesium, Iron, Scotland, Loch of the Lowes, Forfar Loch, Balgavies Loch.

Growth, chlorophyll and mineral nutrients studies were made in Phalaris arundinaceae L. in three Scottish lochs of varying nutrient status from March to November in 1975. The maximum shoot height and shoot dry weight attained by the plants were approximately 160 cm and 4 g respectively. Seasonal changes in the chlorophyll levels in the Phalaris leaf were studied and two peaks were found, one in April and the other in June-July. Maximum chlorophyll level attained was 9 mg g(-1) leaf dry weight. The changes in the mineral levels in the root, stem, leaf and inflorescence parts of the plants from the three lochs were also assayed throughout the growing season. A total of eight mineral elements were studied, including carbon, nitrogen, phosphorus, potassium, sodium, calcium, magnesium and iron. Variations in both the mineral concentrations and their pattern of changes during the study period among the plants from the lochs were observed and discussed. (Steiner-Mass)
W80-05319

**BIOGENIC SEDIMENTARY STRUCTURES PRODUCED BY CRABS IN LAGOON MARGIN AND SALT MARSH ENVIRONMENTS NEAR BEAUFORT, NORTH CAROLINA,**
Mount Holyoke Coll., South Hadley, MA. Dept. of Geology.
E. A. Allen, and H. A. Curran.
Journal of Sedimentary Petrology, Vol. 44, No. 2, p 538-548, June, 1974. 5 Fig, 2 Tab, 20 Ref.

Descriptors: *Crabs, *Burrows, *Salt marshes, *Beach, *North Carolina, Wetlands, Habitats, Aquatic animals, Marshes, Deposition(Sediments), History, Intertidal areas, Distribution patterns.

Intertidal burrowing crabs produce distinctive biogenic sedimentary structures in protected lagoon margin and salt marsh evnironments. Distribution of crabs is determined primarily by substrate characteristics, salinity, and vegetation cover in the intertidal zone. Protected sand beaches and flat are heavily utilized by the sand fiddler, Uca pugilator, while backshore and foredune ridges above the high tide line are used by the ghost crab, Ocypode quadrata. Salt marshes influenced by normal to near normal salinities are burrowed by U. pugilator, Uca pugnax, and Sesarma reticulatum. U. pugnax and S. reticulatum burrow in muddy substrate areas, particularly along tidal creek banks, whereas U. pugilator is restricted to sandy substrate areas. In salt marshes where the influence of freshwater is great, Uca minax and U. pugnax are the dominant crabs. Intertidal crabs are important agents of bioturbation in the environments that they inhabit. Their burrows have excellent potential for preservation in the sedimentary record. Recognition of the record of biogenic sedimentary structures produced by intertidal crabs would be of significant value in identifying paleoenvironments, fixing ancient lagoon margin and estuarine shorelines, and determining paleosalinities. (Steiner-Mass)
W80-05320

**EXPERIMENTAL DEGRADATION OF DETRITUS MADE FROM THE SALT MARSH PLANTS SPARTINA ALTERNIFLORA LOISEL., SALICORNIA VIRGINICA L., AND JUNCUS ROEMERIANUS SCHEELE,**
Georgia Univ., Sapelo Island. Marine Inst.
E. B. Haines, and R. B. Hanson.
Journal of Experimental Marine Biology and Ecology, Vol. 40, p 27-40, 1979. 2 Fig, 3 Tab, 20 Ref.

Descriptors: *Marsh plants, *Degradation(Decomposition), *Efficiencies, *Detritus, Wetlands, Rates, Salt marshes, Deterioration, Marshes, Decomposing organic matter, Georgia, Sapelo Island area(GA).

The pattern of decomposition and potential food value of detritus derived from the C4 photosynthetic pathway plant Spartina alterniflora and the C3 pathway plants Salicornia virginica and Juncus roemerianus were compared. The most rapid decreases in ash-free dry weight and increases in microbial biomass were under aerobic conditions with added nitrogen. Material in aerobic treatments without added nitrogen degraded only slightly faster than in anaerobic treatments. The dissolved organic carbon (DOC) in the cultures was < 5% of the total detrital carbon; the DOC content decreased during the firt week, most rapidly in the aerobic cultures, and then began to increase slowly. Rates of nitrogen fixation in the cultures were low, and were depressed by the pressure of O2 and NH4(+), and by a higher nitrogen content of the detritus. Salicornia detritus initially degraded the fastest but showed the lowest conversion efficiency of plant material to microbial biomass (19.4%). Spartina detritus had the highest conversion efficiency (64.3%), while Juncus, which decomposed most slowly, had a conversion efficiency of 55.6%. From 87% to 100% of the increase in nitrogen content of the plant detritus is ascribed to protein-nitrogen. (Steiner-Mass)
W80-05321

**ACCUMULATION OF TIN BY MANGROVE SPECIES IN WEST MALAYSIA,**
Westfield Coll., London (England). Dept. of Botany and Biochemistry.
P. J. Peterson, M.A.S. Burton, M. Gregson, S. M. Nye, and E. K. Porter.
Science of the Total Environment, Vol. 11, p 213-221, 1979. 1 Fig, 5 Tab, 30 Ref.

Descriptors: *Mangrove swamps, *Metals, *Bioindicators, Wetlands, Plant physiology, Detritus, Swamps, Bioassay, Leaves, Iron, Copper, Zinc, Malaysia, Tin.

Concentrations of tin, iron, copper, and zinc were determined in the leaves of the mangrove species at various sites in West Malaysia in an analysis of the use of such plants as biogeochemical indicators. Results show that the concentrations of all the metals were higher in the leaves than in the twigs, but, whereas the concentration of tin was higher in the old leaves, that of the other three elements was higher in young leaves. A comparison of the metal concentration between Acanthus illicifolius and Rhizophora conjugata reveals that tin and iron are comparable, but zinc and copper are markedly higher in the former. A comparison of the detrital and the mangrove leaves metal concentrations reveals that a considerable increase in metal concentration has taken place in the detritus. Whether these encrichments represent selective adsorption and chemical complexation by decaying leaves or whether they illustrate accumulation by microorganisms requires further studies. Despite the complexity of mangrove ecosystems, results indicate that mangroves could be used to advantage for biogeochemical prospecting and for locating elevated metal levels resulting from pollution. (Steiner-Mass)
W80-05325

**IDENTIFICATION OF PLANT FRAGMENTS AND POLLEN FROM PEAT DEPOSITS IN RANGITAIKI PLAINS AND MAKETU BASINS,**
Massey Univ., Palmerston North (New Zealand). Dept. of Botany.
E. O. Campbell, J. C. Heine, and W. A. Pullar.
New Zealand Journal of Botany. Vol. 11, No. 2, 317-330, June 1973. 3 Fig, 1 Tab, 2 Ref, 1 Append.

Descriptors: *History, *Bogs, *New Zealand, Wetlands, Peat, Palyrology, Succession, Marsh plants, Spores, Pollen Soil-water-plant relationships.

From a study of plant remains (mainly roots), pollen, and fern spores preserved in the peat, it is

possible to construct a picture of the past vegetation in the bog areas on the Rangitaiki plains, New Zealand. The peat, for the most part, was a sedge peat which had developed in low moor bogs with Baumea complanata as the main peat former. There would be free water around the Baumea clumps and around the taller clumps of Cortaderia which is often present. There were drier periods when Gleichemia, Leptospermum, Dacrycarpus, Laurelia, and associated plants tended to establish and wetter periods when the restiads (Calorophus and Sporadanthus), indicative of a raised bog, came in (Steiner-Mass)
W80-05326

**ENVIRONMENTAL FACTORS IN RELATION TO THE SALT CONTENT OF SALICORNIA PACIFICA VAR. UTAHENSIS,**
Brigham Young Univ., Provo, UT. Dept. of Botany.
D. J. Hansen, and D. J. Weber.
Great Basin Naturalist, Vol 35, No 1, p 86-96, March, 1975. 16 Fig, 2 Tab, 30 Ref.

Descriptors: *Plant physiology, *Salinity, *Halophytes, Wetlands, Plant growth, Salt marshes, Environmental effects, Marsh plants.

The stability of the salt content in Salicornia pacifica Standl. var. utahensis (Tidestrom) Munz in relation to environmental changes was investigated. Salicornia pacifica communities have a characteristic soil pH of 7.5 to 8.0 + or - 0.2 and a constant subsurface soil moisture level of 25 to 35 percent. The ion content in the tissue of S. pacifica remained constant despite increased moisture stress throughout the growing season. The concentrations of the salts were significantly higher in the surface soil layers than in the subsurface layers around the roots. Normal metabolic processes in the tissues of S. pacifica appear to occur even though some fluctuations in the ionic balance and concentration of ions in the plant occur. (Steiner-Mass)
W80-05327

## 2J. Erosion and Sedimentation

**MODEL PREDICTIONS OF EFFECTS OF IMPOUNDMENT ON PARTICULATE ORGANIC MATTER TRANSPORT IN A RIVER SYSTEM,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
J. R. Webster, E. F. Benfield, and J. Cairns.
In: The Ecology of Regulated Streams, p 339-364, 1979, Plenum Publishing Corporation. 4 Fig, 1 Tab, 78 Ref.

Descriptors: *Suspended solids, *Suspended load, *Organic matter, *Impoundments, *Model studies, Simulation analysis, Sedimentation, Sediment transport, Reservoirs, Particle size, Leaves, Hydroelectric plants, Erosion, Mathematical studies, Headwaters, Upstream, Standing crops, Seston, *Particulate organic matter transport.

Three empirical equations relating elevation, stream width, and mean annual stream flow to distance were used in a model of the effects of impoundment on particulate organic matter (POM) dynamics in a river-reservoir ecosystem. The model considers the entire river system above an impoundment and for a distance downstream. Data needed to numerically parameterize the model were taken from the New River and Claytor Lake in North Carolina and Virginia. The river goes from first to sixth order and is impacted by impoundment, industrial and urban effluents, and agricultural runoff. The impoundment, a hydroelectric power dam, is located 290 km below the headwaters. Equations are presented for hydraulic parameters, reservoir parameters, biological parameters, and sedimentation and erosion. A 14-month simulation identified several areas where the model does not accurately reflect actual POM behavior including: the seasonality of allochthonous inputs, autochthonous sources of POM, filter-feeder use of POM, and deposition and resuspension of POM. Simulation results did show that POM concentration was highest during leaf fall; during leaf fall POM concentration peaked a short distance downstream from the headwaters; benthic POM was greatest just after leaf fall; and there was a consistent downstream decrease in POM standing crop. Changes occurring within and below the impoundment were also discussed. (Seigler-IPA)
W80-05116

**REACTOR-RELEASED RADIONUCLIDES AND FINE-GRAINED SEDIMENT TRANSPORT AND ACCUMULATION PATTERNS IN BARNEGAT BAY, NEW JERSEY AND ADJACENT SHELF WATERS,**
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 5B.
W80-05130

**THE EFFECT OF TIDAL RESUSPENSION ON THE DISTRIBUTION OF INTERTIDAL EPIPELIC ALGAE IN AN ESTUARY,**
Connecticut Univ., Groton. Marine Sciences Inst.
For primary bibliographic entry see Field 2L.
W80-05132

**VELOCITY PROFILES OVER A RIPPLED BED AND THE THRESHOLD OF MOVEMENT OF SAND,**
Institute of Oceanographic Sciences, Taunton (England).
For primary bibliographic entry see Field 2L.
W80-05133

**POINT BAR AND FLOODPLAIN FORMATION OF THE MEANDERING BEATTON RIVER, NORTHEASTERN BRITISH COLUMBIA, CANADA,**
Wollongong Univ. (Australia). Dept. of Geography.
G. C. Nanson.
Sedimentology, Vol 27, No 1, p 3-29, February 1980. 25 Fig, 1 Tab, 53 Ref.

Descriptors: *Flood plains, *Sedimentology, *Channel morphology, *Canada, On-site investigations, Meandering, Rivers, Stratigraphy, Particle size, Sediments, Velocity, Distribution patterns, Alluvial channels, Deposition(Channels), Sediment transport, Currents(Water), Beatton River(British Columbia), Point bars, Scroll bars, Secondary currents.

This study examined the morphology, sedimentology, and genesis of the point bars and floodplain of the Beatton River. The Beatton River, a 500 km tributary of the Peace River, drains an area of 16,070 sq km near Fort St. John, northeastern British Columbia, Canada. The formation of point bass occurs in distinct stages. An initial point bar platform composed mainly of coarse sediment is formed adjacent to the convex bank of a migrating meander bend and is the base on which develops a single scroll bar of fine traction and suspended load. With continued sedimentation, the scroll bar grows, eventually supporting vegetation and becoming a floodplain ridge. Scroll bars form with greatest size and frequency in rapidly migrating bends, and the shape of the meander bend appears to determine both the location of the initial bar deposit and its direction of growth up or downstream. Approximately one-half of the floodplain sediment is derived from suspended load, and the initiation of a scroll bar appears to be due to excessive deposition of suspended load in a zone of flow separation over a point bar platform. The critical flow condition for the initiation of a scroll bar does not occur with the same recurrence interval on different shaped meander bends, however, the average recurrence interval within the study reach is approximately every 30 years. Sedimentation rates on point bars and on the floodplain indicate two relatively distinct stages of floodplain alluviation. The most rapid is for surfaces less than 50 years old, although sediment accumulation still persists on surfaces up to 250 years in age. Although frequently flooded, surfaces older than this accumulate very little sediment. Despite 2-3 m of overbank deposition, the amplitude of floodplain ridges is maintained by secondary currents which sweep sediment from the swales towards the ridge crests. (Humphreys-ISWS)
W80-05144

**A PHYSICAL MODEL FOR THE TRANSPORT AND SORTING OF FINE-GRAINED SEDIMENT BY TURBIDITY CURRENTS,**
Dalhousie Univ., Halifax (Nova Scotia).
D. A. V. Stow, and A. J. Bowen.
Sedimentology, Vol 27, No 1, p 31-46, February 1980. 11 Fig, 2 Tab, 87 Ref.

Descriptors: *Sediment transport, *Sediment sorting, *Turbidity currents, *Model studies, Sedimentation, Density currents, Turbidity, Deposition(Sediments), Rates, Clays, Silts, Analytical techniques, Particle size, On-site investigations, Mathematical models.

Turbidite muds in cores from the outer Scotian continental margin, off eastern Canada, contain abundant thin silt laminae. Graded laminated units are recognized in parts of this sequence. These represent single depositional events and show a regular decrease in modal grain size and thickness of the silt laminae through the unit. A similar fining trend is shown by both silt and mud layers over hundreds of kilometers downslope. Textural analysis of individual laminae allows the construction of a dynamically consistent physical model for transport and sorting in muddy turbidity currents. Hydraulic sorting aggregates finer material to the top and tail regions of a large turbidity flow which then overspills its channel banks. Downslope lateral sorting occurs with preferential deposition of coarser silt grains and larger mud flocs. Depositional sorting by increased shear in the boundary layer separates clay flocs from silt grains and results in a regular mud/silt lamination. Estimates can be made of the physical parameters of the turbidity flows involved. They are a minimum of several hundreds meters thick, have low concentrations (of the order of 0.001 or 2500 mg/l), and move downslope at velocities of 10-20 cm/s. A 5 mm thick, coarse silt lamina takes about 10 h to deposit, and the subsequent mud layer 'blankets' very rapidly over this. A complete unit is deposited in 2-6 days which is the time it takes for the turbidity flow to pass a particular point. These thick, dilute, low-velocity flows are significantly different from the 'classical' turbidity current. However, there is mounting evidence in support of the new concept from laboratory observations and direct field measurements. (Humphreys-ISWS)
W80-05145

**A SMALL CLIFF-BOUND ESTUARINE ENVIRONMENT: SANDYHAVEN PILL IN SOUTH WALES,**
Reading Univ. (England). Sedimentology Research Lab.
For primary bibliographic entry see Field 2L.
W80-05146

**ESTIMATING THE C FACTOR IN THE UNIVERSAL SOIL LOSS EQUATION FOR LANDSCAPED SLOPES,**
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.
W. R. DeTar, J. J. Ross, and R. L. Cunningham.
Journal of Soil and Water Conservation, Vol 35, No 1, p 40-41, January-February 1980. 2 Fig, 5 Ref.

Descriptors: *Soil erosion, *Erosion, *Mathematical models, *Equations, Model studies, Vegetation effects, Mulching, Trees, Canopy, Shrubs, Grasses, Landscaping, Raindrops, Rainfall, Universal soil loss equation.

The cropping and management factor, C, in the universal soil loss equation has not been measured on landscaped sites common in urban areas. Combinations of trees, shrubs, and groundcover can make the problem seem difficult to handle. Although such sites are usually heavily mulched soon after construction, the mulch deteriorates within a few years, leaving many areas subject to erosion. Wischmeier addressed the problem of soil losses on undisturbed areas, such as woodlands. His ap-

proach was modified to handle the problem in landscaped areas. This procedure represents the best method available for estimating the C factor for landscaped areas in the universal soil loss equation. (Sims-ISWS)
W80-05147

**ESTIMATING THE C FACTOR IN THE UNIVERSAL SOIL LOSS EQUATION FOR LANDSCAPED SLOPES: A FIELD RATING SYSTEM,**
Pennsylvania State Univ., University Park. Dept. of Agronomy.
J. J. Ross, W. R. DeTar, and R. L. Cunningham.
Journal of Soil and Water Conservation, Vol 35, No 1, p 42-44, January-February 1980. 2 Tab, 6 Ref.

Descriptors: *Soil erosion, *Erosion, *Mathematical models, *Equations, Model studies, Vegetation effects, Mulching, Trees, Canopy, Shrubs, Grasses, Landscaping, Raindrops, Rainfall, Universal soil loss equation.

Use of ornamental trees, shrubs, and groundcovers for erosion control is common on steep slopes in urban areas. Organic mulches, such as wood chips, are often used immediately after planting to protect soil and conserve moisture for plants. These mulches effectively control erosion. Despite this initial protection, little attention has been given to these plantings to determine the amount of cover provided by established plants after the mulch has deteriorated. The problem of evaluating cover effectiveness and making recommendations for the use
W80-05148

**HYDROSEEDING FOREST ROADSIDES IN BRITISH COLUMBIA FOR EROSION CONTROL,**
British Columbia Univ., Vancouver. Dept. of Soil Science.
For primary bibliographic entry see Field 4D.
W80-05149

**DESCHUTES RIVER BASIN SUSPENDED SEDIMENT TRANSPORT STUDY,**
Washington State Dept. of Ecology, Olympia.
A. Moore, and D. Anderson.
Project Report DOE-PR-7, July 1979. 24 p, 8 Fig, 1 Tab, 49 Ref.

Descriptors: *Sediment discharge, *Rivers, *Washington, *Suspended load, Sediment transport, Data collections, Suspended solids, Turbidity, Stream erosion, Bank erosion, Monitoring, Tributaries, River systems, *Deschutes River(WA).

The Deschutes River was dammed at its mouth in 1951 forming Capitol Lake, a 220-acre impoundment that is used for salmon culturing (Percival Cove) and a variety of recreational activities. The State of Washington, which is responsible for maintaining the lake, conducted the first major dredging operation during the 1978-79 winter. It became apparent during the planning of the Capitol Lake dredging project that insufficient information was available concerning the sources of the sediments that are reaching the lake. Therefore, during 1976-78, the Department of Ecology conducted sediment monitoring at selected locations in the Deschutes watershed. The study included two objectives: (1) identify sources of sediments transported by the Deschutes River; and (2) determine the quantity and significance of sediments contributed by each of the sources identified. This report presented and discussed the results of the 1977-78 monitoring effort. An estimated 3,043 tons (25%) of the 12,233 tons of suspended sediment originating from the upper Deschutes basin during November and December 1977 came from the tributaries monitored. The stream banks and channel appeared to account for the 9,190 ton (75%) difference. Another 6,029 tons was picked up along the lower Deschutes, nearly all of which appeared to come from the mainstem. These results indicate that the majority of the 18,262 tons (67%) of suspended sediments transported to Capitol Lake originated from the streambed and banks along the mainstem itself. (Humphreys-ISWS)
W80-05153

**MATHEMATICAL MODELING OF SEDIMENT AND CONTAMINANT TRANSPORT IN THE JAMES RIVER ESTUARY,**
Battelle Pacific Northwest Labs., Richland, WA.
Y. Onishi, and S. E. Wise.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 303-310, 1978. 7 Fig, 12 Ref, 1 Append. DOE EY-76-C-06-1830.

Descriptors: *Sediments, *Pollutants, *Rivers, *Mathematical models, Model studies, Sediment transport, Path of pollutants, Pesticides, Heavy metals, Nutrients, Radioactive wastes, Mathematics, Equations, Calibrations, Water pollution, Estuaries, *James River Estuary(VA).

Various contaminants (e.g., pesticides, heavy metals, nutrients, and radionuclides) discharged to surface waters are dispersed by currents, surface waves, and turbulent mixing. These contaminants are also adsorbed from solution onto sediment; thus, otherwise dilute contaminants are concentrated. This process may create a significant pathway to man. For example, contaminated sediments may be deposited onto river and ocean beds. Contaminated bed sediments in turn may become a long-term source of pollution through desorption and resuspension. In contrast, sorption by sediment can be an important mechanism for reducing the area of influence of these contaminants by reducing concentrations of dissolved constituents. To identify the effects of sediment transport on contaminant migration, the finite element sediment and contaminant model (FETRA) was applied to the James River estuary. The modeling procedure for FETRA involved simulating the transport of sediments (organic and inorganic materials) within the water body. The results were then utilized to simulate dissolved and particulate contaminants by taking into account interaction with the sediments. Finally, changes in river bed conditions were calculated including: (1) river bottom elevation change, (2) distributions of ratio of each bed sediment component in the bed, and (3) distribution of contaminants in the river bed. (See also W80-05159) (Sims-ISWS)
W80-05185

**SEDIMENT TRANSPORT IN MIGRATING BED FORMS,**
Science and Education Administration, Oxford, MS. Sedimentation Lab.
J. C. Willis, and J. F. Kennedy.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 551-560, 1978. 4 Fig, 23 Ref, 1 Append.

Descriptors: *Sediment transport, *Laboratory tests, *River beds, *Sediment discharge, Shape, Bed load, Dunes, Alluvial channels, Ripple marks, Mathematical models, Equations, Analytical techniques, Data collections, Statistical methods.

In recent years, application of spectral or time-series analysis to the description of sedimentary dunes has been quite successful. The objectives of the study reported were to develop a more rigorous formulation of dune-load transport based on a spectral description of the dune profiles and movement; to obtain detailed data on sediment transport and dune geometry and motion from a series of carefully conducted flume experiments; and to examine these and other flume data in the light of the new formulation with the goal of developing an improved predictor for the total-load discharge of alluvial streams. A series of 34 experiments was conducted in the 50 ft long, 1.18 ft wide, 2 ft deep, tilting, recirculating flume to obtain the detailed data required to verify the analytical model developed in this paper. Sieved quartz sand, retained between 0.5 mm and 0.7 mm sieves, was used. A detailed size analysis of the sediment gave a median particle size of 0.54 mm, and a median fall diameter of 0.50 mm. In view of the experimental results and the rigorous derivations leading to the duneload discharge relation, the equation not only extends stochastic analysis of bed forms beyond the realm of primarily a descriptive tool but also serves as a promising means for determining the dune-load discharge when bed elevation records are available. (See also W80-05159) (Humphreys-ISWS)
W80-05207

**STOCHASTIC ASPECTS OF WATERSHED SEDIMENT YIELD,**
Colorado State Univ., Fort Collins.
D. A. Woolhiser, and K. G. Renard.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 561-567, 1978. 1 Fig, 14 Ref.

Descriptors: *Watersheds(Basins), *Sediment yield, *Mathematical models, Sediment transport, Sediment discharge, Stochastic processes, Model studies, Theoretical analysis, Analytical techniques, Monte Carlo method, Rainfall, Runoff, Effects.

The sediment yield process may be divided into two categories--the upland phase and the lowland phase. Sediment detachment and transport processes predominate in the upland phase and depend on individual rainfall (or snowmelt) events. The magnitude of erosion from upland phase depends on factors like slope steepness and shape, cover, soil type, land use, and rainfall characteristics. In the lowland phase, sediment transport and deposition processes predominate, and the bed load transport capacity becomes a significant factor because channel flow is normally capable of transporting all the fine material available. Sediment transport rates are determined by hydraulic variables, like the flow depth and velocity, channel slope, water temperature, and physical properties of the sediments. The effect of individual precipitation events is highly damped. From examples in the literature, it appears that stochastic models of sediment yield have important application in design of dams, debris-basins, and other hydraulic structures. The approaches used in developing stochastic sediment yield models range from detailed, physically based models with distribution functions obtained by sampling from Monte Carlo simulations to empirical, event-based models for which distribution functions of sediment yield can often be obtained analytically. The best approach for any particular application depends greatly on the available data as well as the size of the watershed. (See also W80-05159) (Humphreys-ISWS)
W80-05208

**ESTIMATING THE RISK OF CHANNEL EROSION,**
Colorado Univ. at Denver. Dept. of Civil Engineering.
W. C. Hughes.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 568-573, 1978. 2 Fig, 1 Ref, 1 Append.

Descriptors: *Channel erosion, *Estimating, *Analytical techniques, *Risks, Data collections, Analysis, Erosion, Discharge(Water), Mathematical models, Statistical methods, Stream erosion, Soils, Sands, Gravels, Clays, Probability, Silts, Erosion potential.

The objective of the study described was to develop a method for estimating the potential for channel erosion, which would incorporate the random tendency of the variables while retaining data and computational requirements comparable to the permissible velocity method. The study involved two phases: The first phase was an analysis of field data to develop curves relating the probability of significant erosion in a channel to flow rate, hydraulic characteristics, and soil conditions. These curves were referred to as erosion potentials. The second

phase was the derivation of a procedure for combining a channel's erosion potential with the channel's discharge frequency curve to yield the probability, or risk, of erosion in a given reach of stream channel. The latter provides a method for accounting for situations where the likelihood of erosion is quite low, even in a highly erodible channel, simply because erosion-producing discharges occur infrequently. The proposed method provides a quick means to estimate the erosion risk in a stream channel using data which is normally available. The method cannot replace an extensive erosion survey but was not intended to do so. The sand-silt, silt-clay, and clay erosion potential diagrams have an acceptable degree of statistical reliability although upper boundary on clay erosion potential diagram is somewhat questionable. The gravel-silt erosion potential diagrams are of marginal statistical reliability. When channel discharges exceed 10 cfs, the risk of channel erosion can be estimated directly from the appropriate erosion potential diagram. (See also W80-05159) (Humphreys-ISWS)
W80-05209

**SEDIMENT AND PCB TRANSPORT MODEL OF THE HUDSON RIVER,**
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
G. A. Apicella, and T. F. Zimmie.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 645-653, 1978. 2 Fig, 2 Tab.

Descriptors: *Model studies, *Sediment transport, *Polychlorinated biphenyls, *Hudson River, Mathematical models, Sediments, Rivers, Deposition(Sediments), Bed load, Scour, On-site investigations, Calibrations, Methodology, Analytical techniques, Sediment discharge, *Lock 7(NY), *Troy dam(NY).

The purpose of this study was to model mathematically the transport of PCB-contaminated sediments through a 40-mile segment of the Upper Hudson River. Furthermore, because PCBs were recognized to be present in both the river bed and water column partitions of the river system, the major objectives were to analyze the stability of the PCB-laden sediments lying on the river bed and project the contaminant loading of the upper river to the estuary. The area modeled includes approximately 40 miles of the Hudson River between Lock 7 (RMI 193.7) and the Troy dam (RMI 153.9), and represents a total drainage area of 8090 sq mi. A series of eight dams divides this portion of the river into eight reaches defined as the extent of river from oe dam to the next. A systems analysis approach to the study consisted of various submodels that relate the quantity of flow through the river to an associated sediment load, which contains a certain mass of PCB in transport. This analysis which assumes the continuation of natural river conditions serves as a benchmark for comparing various remedial action programs. This modeling framework is capable of assessing the effects of various remedial alternatives and should be applied to the partial dredging program currently under consideration. (See also W80-05159) (Humphreys-ISWS)
W80-05219

**SEDIMENT MOVEMENT IN A SMALL HUMID WATERSHED,**
Hawaii Univ., Honolulu.
P. D. Bartram, and G. L. Dugan.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 654-661, 1978. 3 Fig.

Descriptors: *Sediment transport, *Small watersheds, *Hawaii, *Model studies, Sedimentation, On-site investigations, Suspended solids, Suspended load, Turbidity, Storm runoff, Deposition(Sediments), Analysis.

Water quality standards pertaining to sediments require some kind of mathematical model. It is advantageous for water quality management if such models are fairly simple and highly transferrable to situations other than the areas where they are first developed and calibrated. This paper examined three different approaches--criteria or standards--that might have been applied to a perennial stream discharging to a large embayment in Hawaii. Each standard was useful for a limited part of the overall range of sediment pollution. Turbidity was the best indicator of sediment problems during low flow periods; suspended sediment concentration arrayed in a log-normal distribution was the best indicator of deviations for storm flow events up to the most extreme occurrences; and the thickness of sediment deposited over living corals on the reef was the best indicator for the most extreme storm runoff events. Most of the documented sediment damage to reef ecology in Kaneohe Bay was associated with extreme flood events, which occurs when the rate of sediment deposit exceeds the rate of removal by waves and the self-cleansing ability of the coral animals themselves. If the thickness exceeds 0.12 inch for a period of even one day, the more silt-resistant species of coral would be smothered to death. (See also W80-05159) (Humphreys-ISWS)
W80-05220

**A SEDIMENT YIELD ROUTING MODEL,**
Science and Education Administration, Temple, TX.
J. R. Williams.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 662-670, 1978. 2 Tab, 5 Ref.

Descriptors: *Sediment yield, *Routing, *Mathematical models, *Agricultural watersheds, Model studies, Equations, Deposition(Sediments), Degradation(Stream), Analytical techniques, Analysis, Bed load, Open channels, Sediment discharge, Sediment routing model.

A model for routing individual storm sediment yields through large agricultural basins was described. The model consists of two components for simulating the deposition and degradation processes. Deposition depends upon sediment particle size and the change in peak flow rate within a routing reach. The deposition model was developed previously but was restructured here to exclude channel and floodplain degradation. Previously, the sediment routing model contained a crude degradation component based on MUSLE. A new degradation model based on stream power was developed in this paper. One of the stream power parameters, evaluated for bed load prediction, was used in the degradation model. A technique was developed for estimating the other parameter. Although more work is needed to validate the parameter estimates, the stream power approach has a stronger physical basis than the previous degradation model. Also, the new model outputs sediment graphs resulting from degradation. Only the total degradation could be predicted with the original model. Tests with data from three Texas basins showed that the sediment-routing model gives realistic predictions. The model should be useful in determining nonpoint source pollution because it operates on individual storms and identifies subbasin contributions. (See also W80-05159) (Humphreys-ISWS)
W80-05221

**FIELD TEST OF A DISTRIBUTED SEDIMENT YIELD MODEL,**
Science and Education Administration, Oxford, MS. Sedimentation Lab.
C. V. Alonso, D. G. DeCoursey, S. N. Prasad, and A. J. Bowie.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 671-678, 1978. 7 Fig, 6 Ref.

Descriptors: *Sediment yield, *Small watersheds, *On-site tests, *Model studies, Hydrographs, Sediments, Discharge(Water), Erosion, Analysis, Forecasting, Runoff, Sediment discharge, Sediment yield model.

This paper described a computational model for predicting the unsteady movement of water and sediment generated by single runoff events. The model basically consists of two intertwined models: one describing the hydrology of the basin, the other describing the associated erosion and sedimentation processes. The present model simulates the movement of water and sediment as a time and space distributed process, and it has the ability of distinguishing between overland and channel flows. The watershed is regarded as consisting of a mosaic of individual but interconnected subcatchments. Within each of these subcatchments, the characteristics of the terrain and precipitation distribution are assumed uniform. The model can thus be regarded as a cascading process in which the output of one or more subcatchments becomes the input to another subcatchment or channel reach. In mimicking the overland movement of water and sediment, the model simulates processes of interception, infiltration, runoff, detachment, transport, and deposition of sediment. The water and sediment reaching the streams are then routed through the channel system, and the rates of channel aggradation and degradation are computed. The applicability of the model is restricted, so far, to watersheds where the streamflows are ephemeral, the subsurface flow and groundwater movement are not significant, and the kinematic wave approximation for flow routing is valid. (See also W80-05159) (Humphreys-ISWS)
W80-05222

**FIELD VERIFICATION OF SEDIMENT TRANSPORT MODEL,**
Florida Univ., Gainesville. Dept. of Coastal and Oceanographic Engineering.
For primary bibliographic entry see Field 2L.
W80-05228

**THE LOYALSOCK CREEK MODEL STUDY,**
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W80-05229

**SEDIMENT MODEL VERIFICATION FOR SMALL DIVERSIONS,**
Water and Power Resources Service, Denver, CO.
R. A. Dodge.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 753-758, 1978. 2 Tab, 1 Ref.

Descriptors: *Model studies, *Sediments, *Diversion, Calibrations, Sediment transport, Hydraulic models, Methodology, Sediment load, Roughness(Hydraulic), Roughness coefficient, Froude number, Hydraulics, Hydraulic similitude, Model verification.

Normalized equations, whether solvable or not, aid in the design and verification of a model by showing what dimensionless parameters are involved and what groups of dimensionless variables for which they are coefficients. Verification should be directed to finding the values of these parameters for both the model and prototype, then the modeler can determine for what ranges the model is valid, and in some cases the error of some of the variables can be determined and possibly corrected if distortion is not too great. For coarser bed materials, the portion of the grain distribution that governs roughness can also nearly scale geometrically. Thus, both friction and relative roughness can be the same for model and prototype. Verification data, especially for a rehabilitation model, help develop a base for the existing system to compare proposed modifications in a more quantitative way. For sediment models of small diversions the modeler is dependent upon the skill of hydrologists in making flow duration analyses computation of water surface levels and sediment load to augment scarce field data. Adequate verification effort can help substantiate bed sampling, computed hydrologic estimates, and mathematical models as well as the physical modeling techniques used. (See also W80-05159) (Humphreys-ISWS)

W80-05230

**BED LOAD: DEFINITION AND MEASUREMENT,**
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 7B.
W80-05231

**A FACTOR ANALYSIS OF ELEMENTAL ASSOCIATIONS IN THE SURFACE MICROLAYER OF LAKE MICHIGAN AND ITS FLUVIAL INPUTS,**
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
For primary bibliographic entry see Field 2H.
W80-05254

**SEDIMENTATION RATES AND A SEDIMENT BUDGET FOR LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05285

**SEDIMENTS OF LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05286

**RECONNAISSANCE ASSESSMENT OF EROSION AND SEDIMENTATION IN THE CANADA DE LOS ALAMOS BASIN, LOS ANGELES AND VENTURA COUNTIES, CALIFORNIA,**
Geological Survey, Menlo Park, CA. Water Resources Div.
J. M. Knott.
Available from GPO Washington DC 20402. Paper copy $2.00. Geological Survey Water-Supply Paper 2061, 1980. 26 p, 15 Fig, 2 Tab, 16 Ref.

Descriptors: *Sediment yield, *Mechanical equipment, *Accelerated erosion, *Erosion rates, Evaluation, California, *Off-road vehicles, Ventura County(Calif), Los Angeles County(Calif), Hungry Valley, Canada de Los Alamos.

An assessment of present erosion and sedimentation conditions in the Canada de Los Alamos basin, Calif., was made to aid in estimating the impact of off-road-vehicle use on the sediment yield of the basin. Evaluations were made by reconnaissance techniques and by comparing the study area with other off-road-vehicle sites in California. Major-storm sediment yields for the basin were estimated, using empirical equations developed for the Transverse Ranges and measurements of gully erosion in a representative off-road vehicle basin. Normal major-storm yields of 73,200 cubic yards would have to be increased to about 98,000 cubic yards to account for the existing level of accelerated erosion caused by off-road vehicles. Long-term sediment yield of the Canada de Los Alamos basin upstream from its confluence with Gorman Creek, under present conditions of off-road-vehicle use, is approximately 420 cubic yards per square mile per year--a rate that is considerably lower than a previous estimate of 1,270 cubic yards per square mile per year for the total catchment area above Pyramid Lake. (Kosco-USGS)
W80-05305

**OIL SPILL VULNERABILITY, COASTAL MORPHOLOGY, AND SEDIMENTATION OF KOTZEBUE SOUND,**
South Carolina Univ., Columbia. Div. of Coastal Research.
For primary bibliographic entry see Field 5C.
W80-05339

**BOTTOM AND NEAR-BOTTOM SEDIMENT DYNAMICS IN LOWER COOK INLET,**
Geological Survey, Menlo Park, CA. Branch of Pacific-Arctic Marine Geology.
For primary bibliographic entry see Field 5B.
W80-05349

**SOURCES, TRANSPORT PATHWAYS, DEPOSITIONAL SITES AND DYNAMICS OF SEDIMENTS IN THE LAGOON AND SHALLOW MARINE REGION, NORTHERN ARCTIC ALASKA,**
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5C.
W80-05354

## 2K. Chemical Processes

**GROWTH INHIBITION OF HYDRILLA VERTICILLATA BY SELECTED LAKE SEDIMENT EXTRACTS,**
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 2H.
W80-05258

**A COPPER ANOMALY IN WESTERN LAKE SUPERIOR,**
Canada Center for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05275

**CHEMISTRY OF LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05276

**MAJOR ION LOADINGS TO LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05277

## 2L. Estuaries

**APPROXIMATION FOR SALT-WATER INTRUSION IN UNCONFINED COASTAL AQUIFER,**
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
B. K. Panigrahi, A. Das Gupta, and A. Arbhabhirama.
Ground Water, Vol 18, No 2, p 147-151, March-April 1980. 5 Fig, 16 Ref.

Descriptors: *Saline water intrusion, *Coasts, *Aquifers, *Model studies, Mathematical models, Saline water-freshwater interfaces, Equations, Groundwater, Groundwater movement, Permeability, Water levels, Density, Unconfined coastal aquifers.

A numerical model based on a finite difference technique was developed to analyze and solve the problem of an unconfined coastal aquifer of infinite extent with free surface and interface along with the width of outflow face as unknown boundaries. The problem was formulated in a complex potential plane, and a five-point operator of a finite difference scheme was used to reduce the governing flow equation into a set of linear algebraic equations which was solved by the Gauss-Seidel iterative method with an overrelaxation factor. Results of the analysis provided a generalized dimensionless plot for assessing the freshwater flow to the sea from the known field information of aquifer characteristics and water-table head landward from the shoreline. (Sims-ISWS)
W80-05126

**THE EFFECT OF TIDAL RESUSPENSION ON THE DISTRIBUTION OF INTERTIDAL EPIPELIC ALGAE IN AN ESTUARY,**
Connecticut Univ., Groton. Marine Sciences Inst.
P. W. Baillie, and B. L. Welsh.
Estuarine and Coastal Marine Science, Vol 10, No 2, p 165-180, February 1980. 10 Fig, 2 Tab, 50 Ref. Army DACW 33-75-C-0059.

Descriptors: *Estuaries, *Algae, *Chlorophyll, *Suspended solids, *New England, Sampling, On-site investigations, Laboratory tests, Zooplankton, Diatoms, Benthic flora, Biomass, Microorganisms, Biological communities, Sediments, Tides, Tidal effects, Circulation, Water circulation, Biology, Mud flats, Coasts, Resuspension.

The distribution of microalgal biomass in the sediments and water column of a salt marsh and mudflat ecosystem was studied over a 15-month period by fluorometric analysis of chlorophyll a. Chlorophyll entered the water column on the early flood tide due to the resuspension of intertidal mudflat sediments and associated epipelic algal flora. By mid-flood tide, chlorophyll values were surpassed by its degradation products. Unusually large numbers of bivalves and other suspension feeders present in the system may have processed the water and released fecal materials, thus raising the concentration of pheopigment in the water column between early and mid-flood tide. By mid-ebb, the pigment levels had declined, possibly due to the settling of algal cells and feces. Resuspension recommenced briefly by late ebb as the system emptied. Calculations revealed that if 10 to 15% of the mudflat sediments were resuspended to a depth of 1 mm, it could account for the chlorophyll levels inside the estuary which were high compared to neighboring systems. Pigment gradients in the water column and sediments indicated net transport of epipelic algae from the mudflat to the salt marsh where most of the bivalves were located. Suspended material concentrations as well as counts of epipelic and phytoplankton furstules suggested that epipelic algae in shallow estuarine systems may be an important food source for the filter feeding community when made available twice daily by tidal resuspension of sediments. (Sims-ISWS)
W80-05132

**VELOCITY PROFILES OVER A RIPPLED BED AND THE THRESHOLD OF MOVEMENT OF SAND,**
Institute of Oceanographic Sciences, Taunton (England).
K. R. Dyer.
Estuarine and Coastal Marine Science, Vol 10, No 2, p 181-199, February 1980. 12 Fig, 1 Tab, 28 Ref.

Descriptors: *Ripple marks, *Sediment transport, *Sands, *Coasts, Tides, Tidal effects, Circulation, Water circulation, Shear stress, Velocity, Sediments, On-site investigations, Current meters, Data processing, Analytical techniques, Roughness(Hydraulic), Flow friction, Oceanography, *England coast.

Measurements of velocity profiles were obtained within 2m of the sea bed over a rippled sand in Start Bay, Devon, U.K. Simultaneous observation by underwater television has enabled the threshold of movement of the sand to be determined. The threshold criteria are considerably higher than laboratory measurements for a flat bed. As the sand moves, the ripples change their shape. This causes a change in the bottom roughness length, the drag coefficient, and the apparent threshold of sand movement during the tidal cycle. The bottom roughness length and the threshold of movement also increase with decreasing tidal amplitude. The calculated suspended sediment concentration at the height of bed roughness length was proportional to the normalized excess shear stress with a constant of proportionality of 0.000078. The concentration at a height of 10 cm was proportional to (u sub *) to the 5th power. (Sims-ISWS)
W80-05133

**REGULATION OF SULFATE CONCENTRATIONS AND METHANOGENESIS IN SALT MARSH SOILS,**
Georgia Univ., Athens. Dept. of Microbiology.
G. M. King, and W. J. Wiebe.
Estuarine and Coastal Marine Science, Vol 10, No 2, p 215-223, February 1980. 4 Fig, 1 Tab, 29 Ref.

NSF DES75-20842.

Descriptors: *Salt marshes, *Soil properties, *Sulfates, *Methane, *Georgia, Coasts, Soils, Vegetation, Vegetation effects, Grasses, Marshes, Sampling, Cores, Laboratory tests, Chemistry, Soil chemistry, Soil tests, Soil science, *Georgia coast, Methanogenesis, Salt marsh soils.

Controls of methanogenesis in soils of Sapelo Island, Georgia, salt marshes were investigated by altering water movement through soils of the tall Spartina alterniflora region (TS). Vertical water movement was shown to maintain the concentration of sulfate at levels near that of the tidal waters which flood the TS. Restriction of vertical water movement resulted in a decrease of interstitial sulfate concentration by a factor of 2-5 over a period of 2 months. This decrease in sulfate was accompanied by a marked increase in vitro methane production. Sulfate depletion was postulated to occur in microzones within the soil; methane formation occurs subsequent to this depletion. In situ differences between methanogenesis in TS and SS regions were suggested to be the result of such depletion. (Sims-ISWS)
W80-05134

**A PHYSICAL MODEL FOR THE TRANSPORT AND SORTING OF FINE-GRAINED SEDIMENT BY TURBIDITY CURRENTS,**
Dalhousie Univ., Halifax (Nova Scotia).
For primary bibliographic entry see Field 2J.
W80-05145

**A SMALL CLIFF-BOUND ESTUARINE ENVIRONMENT: SANDYHAVEN PILL IN SOUTH WALES,**
Reading Univ. (England). Sedimentology Research Lab.
C. J. H. King.
Sedimentology, Vol 27, No 1, p 93-105, February 1980. 7 Fig, 2 Tab, 28 Ref.

Descriptors: *Estuaries, *Estuarine environment, *Deposition(Sediments), *On-site investigations, Tidal waters, Stratigraphy, Geomorphology, Erosion, Bank erosion, Aquatic life, Sediments, Aquatic plants, Aquatic animals, Biota, Spatial distribution, United Kingdom, *Sandyhaven Pill(South Wales), Cliff erosion.

Sandyhaven Pill is a 'drowned valley' type of estuary. Thus the deposits differ from most other described estuarine deposits which are of 'tidally influenced river' type. The surface sediments may be divided broadly into wave-dominated deposits (22% of area), tide-dominated deposits (65%), deposits related to marginal cliff collapse (12%), and river-dominated deposits (1%). Further subdivision shows that the subenvironments are nested in a progression up the estuary with trends to finer sediment size, reduced sorting, and increased biogenic activity. The latter relates to a marine to estuarine faunal change and a strong relationship between the distributions of biota and depositional subenvironments. Over a 29 day period, reduction in wave height was reflected in wave-dominated areas by shoreward movement of some subenvironment boundaries and by improved definition of symmetrical ripples. The tidal cycle had only a limited effect on the tide-dominated sediments. The most reliable indicators of estuary trend are channels and asymmetrical ripples; but coring shows that ripples and other minor structures are rarely preserved. Heavy mineral analysis indicates that most of the estuarine sand came from offshore. Gradual sediment buildup will result in a regressive sequence. If this were preserved under a later transgression, the resultant deposit would be an elongate sediment body bounded laterally by a coarse marginal facies. The sediment sequence would be inward and upward fining with diachronous facies boundaries sloping upwards towards the offshore end and towards the axis of the body. (Humphreys-ISWS)
W80-05146

**LOCAL AND SHOALED COMPARISONS OF SEA SURFACE ELEVATIONS, PRESSURES, AND VELOCITIES,**
Scripps Institution of Oceanography, La Jolla, CA. Shore Processes Lab.
R. T. Guza, and E. B. Thornton.
Journal of Geophysical Research, Vol 85, No C3, p 1524-1530, March 20, 1980. 10 Fig, 3 Tab, 17 Ref. ONR NR388-114, N000014-75-C-0300.

Descriptors: *Waves(Water), *Ocean waves, *Beaches, *Surf, Coasts, Shores, On-site investigations, Measurement, Pressure, Velocity, Water levels, Data processing, Analytical techniques, Theoretical analysis, Wave spectra, Shoaling.

Sea surface elevations, or pressures, and velocities were measured at closely spaced (wavelength or less) locations in a line extending from 10-m depth to inside the surf zone at Torrey Pines Beach, San Diego, California. Intercomparisons of local pressure, velocity, and sea surface elevation spectra for the wind wave frequencies (0.05-0.3 Hz) were made by using linear wave theory. Errors in both total variance and energy density in a particular frequency band were less than 20% both inside and outside the surf zone, except in the immediate vicinity of the breakpoint, where larger disparities were observed. Surface elevation spectra calculated at 10 m were shoaled by using linear wave theory. The total variance of stations between 10- and 3-m depth were typically predicted with less than 20% error, although harmonic amplification and other nonlinear effects can lead to significant errors in the prediction at particular frequency bands. Observations inside 3-m depth significantly departed from the predictions of linear shoaling theory. (Sims-ISWS)
W80-05150

**TEMPORAL AND SPATIAL VARIABILITY IN LONGSHORE MOTION ALONG THE TEXAS GULF COAST,**
Harbor Branch Foundation, Inc., Fort Pierce, FL.
N. P. Smith.
Journal of Geophysical Research, Vol 85, No C3, p 1531-1536, March 20, 1980. 6 Fig, 2 Tab, 15 Ref. BLM AA550-CT7-11.

Descriptors: *Currents(Water), *Coasts, *Texas, *Gulf of Mexico, *Variability, On-site investigations, Ocean currents, Current meters, Measurement, Temporal distribution, Spatial distribution, Data processing, Water circulation, Oceans, Oceanography, Longshore motion, Texas Gulf Coast.

Recording current meter data from a 43-day period in the summer of 1977 were used to investigate longshore coherence at three study sites along the central and lower Texas coast in the northwestern Gulf of Mexico. Mid-depth current data from inner shelf waters revealed an alternating longshore motion that is coherent with the longshore component of the wind stress. Current reversals occured over time scales of the order of 1-2 weeks, but there was a net displacement into the north-northeasterly quadrant at all three locations. Transient periods of convergence and divergence were suggested between adjacent study sites as a result of not quite simultaneous reversals in longshore motion, or gradients in longshore motion in the same sense. Spectral analysis of the longshore current components indicated that motion is very nearly in phase along this part of the coast and that the flow is highly coherent over time scales in excess of about 3 days. (Sims-ISWS)
W80-05151

**VERIFICATION OF A STORM TIDE MODEL FOR BOSTON,**
Harris (Frederic R.), Inc., New York.
M. J. McCarthy, E. J. Schmeltz, and R. G. Dean.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 172-188, 1978. 24 Fig, 11 Ref.

Descriptors: *Tides, *Model studies, *Storms, *Harbors, *Massachusetts, Floods, Tidal effects, Tidal waters, Calibrations, Hurricanes, Analytical techniques, Storm surge, On-site investigations, Analysis, Methodology.

This paper deals with the verification of a numerical winter storm surge model. The coastal areas for which flood elevations were determined include the northern portion of Boston Harbor extending into the Mystic, Charles, and Chelsea Rivers to the upstream limits of tidal flow. Much of the coastline in the study area is bordered by piers and wharves with an average elevation 10 feet above mean sea level (MSL). The coastline of South Boston bordering Dorchester Bay consists mainly of beaches which slope steeply upward to approximately 10 feet above MSL. The major storms affecting the study area are winter storms commonly known as Northeasters. The numerical model developed to calculate winter storm surges was found to agree well with observed water levels for the various winter storms studied. The Bathystrophic assumptions made in order to limit computing time and expense did not significantly affect the calculated water levels. These assumptions were possible due to the extremely large size of the winter storms in the Boston area and the predominance of these storms in the determination of maximum storm tide levels. The assumption of an elliptical pressure field was also shown to reflect accurately the observed winter storm pressure fields studied. (See also W80-05159) (Humphreys-ISWS)
W80-05173

**GROUNDWATER SIMULATION FOR KOEBERG POWER STATION,**
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Hydraulic Engineering.
D. Stephenson.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 197-205, 1978. 3 Fig, 5 Ref.

Descriptors: *Groundwater, *Model studies, *Saline water intrusion, *Hydrogeology, Coasts, Mathematical models, Foreign research, Groundwater movement, Aquifers, Transmissivity, Storage coefficient, Calibrations, On-site investigations, *South Africa.

The Koeberg Nuclear Power Station in South Africa is under construction. The foundations of the station are below sea level and there is a possibility of seawater corroding the sand-cement concrete raft unless the seawater/fresh water interface is controlled and the depression in the water table, caused by dewatering, is replenished with fresh water. A computer program was developed to simulate the water table fluctuations and groundwater flow in the vicinity of the foundations. Pumping tests were performed to determine the geohydrological coefficients. Fissures in the bedrock caused inflows not predicted by the computer model until the geohydrological coefficients were suitably adjusted. The model successfully predicted the seawater encroachment into the foundation area of the power station during dewatering. It was further predicted that once foundation construction was complete and the water table permitted to revert to normal, saline water would be drawn into the cutoff area. Replenishment with fresh water within the cutoff area instead of saline water would be a solution. The model could also be used to simulate the flow and dispersion of contaminated water if there were a leak from the station. (See also W80-05159) (Humphreys-ISWS)
W80-05174

**THE OPTIMIZATION OF PUMPING OPERATIONS IN THE EL SOCORRO AQUIFER BY MATHEMATICAL MODELLING,**
National Water Authority of Jamaica (West Indies).
For primary bibliographic entry see Field 2F.
W80-05176

**COMPARISON OF VERIFIED PHYSICAL AND MATHEMATICAL MODEL,**
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
C. Y. Kuo, and C. H. Blair.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of



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the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 222-229, 1978. 6 Fig, 6 Ref.

Descriptors: *Estuaries, *Model studies, *Tides, *Virginia, Calibrations, Water levels, Tidal effects, Hydraulic models, Mathematical models, Currents(Water), Salinity, Water quality, Analysis, *Lafayette River(VA), *Norfolk(VA), Model verification.

A physical model and a mathematical model have been used to study the Lafayette River, a small well-mixed estuary in Norfolk, Virginia. The studies include the tide heights, currents, salinity distributions, and mass transport. Both types of model were verified. Results from physical and mathematical models were compared. The physical model is a Froude model having horizontal scale of 1:540 and vertical scale of 1:12. Adjustment by roughness strips produced close agreement of physical model-prototype tide heights, currents, and salinity. An existing one-dimensional network mathematical model of LaGrangian formulation, developed by Brandsma, Lee, and Bowerman, was modified to predict hydrographic information and dispersion of mass in the Lafayette River. The tidal heights, currents, and salinity distribution in the physical model were calibrated against the prototype data. The objective was to achieve the best overall agreement in adjustments for all three quantities at all stations with a reasonable degree of accuracy. The three quantities in the physical model compared favorably with those in the prototype. The mathematical model simulated the desired tidal heights and current velocities quite well. The conjunctive use of the physical and mathematical models provides a useful tool to check each other and therefore increases the confidence level of the modeling techniques. (See also W74-05698 and W80-05159) (Humphreys-ISWS)
W80-05177

**A DYNAMIC ESTUARY MODEL OF CHARLESTON HARBOR,**
CH2M/Hill, Reston, VA.
M. G. Taylor, R. S. Taylor, and M. R. Stansbury.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 230-236, 1978. 1 Ref.

Descriptors: *Harbors, *Hydraulics, *Water quality, *Model studies, Mathematical models, Estuaries, Rivers, Flow, Streamflow, Pollutants, Path of pollutants, Rainfall, Winds, Evaporation, Sampling, Data processing, Calibrations, *Charleston Harbor(SC).

The Dynamic Estuary Model (DEM) was modified for application to the Charleston Harbor, South Carolina. A network of 17 tide gages provided the historical record for calibration and verification of the hydrodynamic portion of the model for the three main branches of the estuary, the Cooper, Wando, and Ashley rivers. Modifications to the model allowed acceptance of historical boundary tide elevation inputs and stage dependent channel roughness coefficients. System response to large diurnal fluctuations in Pinopolis Dam freshwater releases from Lake Moultrie at the head of the Cooper River verified the use of hydrograph inputs to the model. A water quality sampling program conducted in short, intensive periods over a 14-day period at 20 sites provided the data base for calibration of the water quality portion of the model. Conductivity measurements, in the absence of flow measurements, provided additional verification of the hydraulics calibration of the rivers. The model was used to analyze the impact of rediversion of freshwater from Lake Moultrie to the Santee River and for evaluating alternative water quality management planning strategies developed in the 208 areawide wastewater management plan being done by the Berkeley-Charleston-Dorchester Council of Governments. (See also W80-05159) (Sims-ISWS)
W80-05178

**VERIFICATION OF AN ESTUARINE MODEL FOR APALACHICOLA BAY, FLORIDA,**
Florida Univ., Gainesville. Dept. of Civil Engineering.
D. S. Graham, J. M. Hill, and B. A. Christensen.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 237-245, 1978. 8 Fig, 7 Ref. NOAA 04-7-158-44046.

Descriptors: *Estuaries, *Water quality, *Model studies, *Remote sensing, *Florida, Satellites(Artificial), Mathematical models, Calibrations, Turbidity, Hydrogen ion concentration, Suspended solids, Dissolved oxygen, Water pollution, Color, Rivers, Coasts, Tidal waters, *Apalachicola Bay(FL).

The water quality management process in Florida requires analysis of the effects of basin activities and associated point and nonpoint effluents upon its important coastal zone. Determination of the effects of nonpoint source pollution from agricultural and silvicultural activites, as required by Section 208(I) of the Federal Water-Quality Act of 1972 Amendments, has proved to be particularly difficult. A current research project at the Hydraulic Laboratory of the University of Florida involves linking appropriate currently available basin runoff and estuarine models to quantitatively predict the transient effects of runoff emanating from upland basin activities, particularly forestry practices, upon the biology and water quality of Apalachicola Bay, FL. A cooperative project with the EPA Remote Sensing Laboratory in Las Vegas provided several Landsat images of both Apalachicola Bay and the Tate's Hell Swamp area. Special analyses of spectral signatures allowed differences in surface water color and turbidity to be highlighted, and a set of images was produced in which characteristic circulation patterns may be distinguished. Examination of properly processed Landsat images can allow stationary sampling stations to be advantageously placed, and provides great ability to correctly extrapolate data spatially from a few sampling stations. The data so gathered and estimated are instantaneous and therefore amenable to verification of so-called real-time water quality and hydrodynamic numerical models. (See also W80-05159) (Sims-ISWS)
W80-05179

**VERIFICATION OF A YORK RIVER ECOSYSTEM MODEL,**
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5C.
W80-05180

**MATHEMATICAL MODELING OF SEDIMENT AND CONTAMINANT TRANSPORT IN THE JAMES RIVER ESTUARY,**
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2J.
W80-05185

**A MATHEMATICAL MODEL FOR WATER QUALITY ANALYSIS,**
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5B.
W80-05190

**VERIFICATION OF FINITE ELEMENT HYDRODYNAMIC MODEL CAFE,**
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
J. D. Wang.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 500-508, 1978. 5 Fig, 2 Ref.

Descriptors: *Bays, *Estuaries, *Water circulation, *Hydrodynamics, *Model studies, Mathematical models, Finite element analysis, Shallow water, Coasts, Circulation, Currents(Water), Tidal waters, Tides, Tidal effects, Boundary processes, *Biscayne Bay(FL).

In recent years the adaptation of numerical models to predict the tidal hydraulics of coastal embayments and estuaries has become an important tool in environmental studies. For shallow water bodies the two-dimensional vertically integrated or averaged models are the most widely used. Early finite difference models suffer from difficulties in treating complicated boundaries properly; however, several new techniques have been introduced to overcome these problems and to allow for a variable grid network. The Circulation Analysis with Finite Elements model (CAFE) represents one of these newer developments. Although these models aid in the qualitative understanding of fundamental physical processes, their primary purpose is to provide quantitative data. Confidence in the performance of these models under varying conditions as well as user proficiency must be established through verification. This paper described the field comparison for CAFE in South Biscayne Bay, Florida. Similar bays are found throughout southern Florida and along the Gulf coast. Although put to a severe test, since no adjustments were attempted, the hydrodynamic model, CAFE, gave a reasonable prediction of overall flow patterns in Biscayne Bay. The model, therefore, seems to describe correctly the principal physical processes. The main obstacles in obtaining accurate quantitative results lie in correct schematization and prescription of boundary conditions. (See also W80-05159) (Sims-ISWS)
W80-05202

**VERIFICATION OF A NUMERICAL FLOW MODEL FOR CAROLINA BEACH INLET, NORTH CAROLINA,**
North Carolina State Univ. at Raleigh. Center for Marine and Coastal Studies.
T. C. Gopalakrishnan, and J. L. Machemehl.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 509-517, 1978. 6 Fig, 5 Ref. NOAA 04-6-158-44054.

Descriptors: *Inlets(Waterways), *Currents(Water), *Water circulation, *Model studies, *North Carolina, Mathematical models, Circulation, Velocity, Tidal waters, Tides, Tidal effects, Flow, Analytical techniques, Finite element analysis, Estuaries, Coasts, *Carolina Beach Inlet(NC).

The numerical flow model developed by Machemehl and Gopalakrishnan for computation of flow in tidal inlets with junctions has been applied to Carolina Beach Inlet, North Carolina. The model couples the Galerkin Technique with a finite element analysis. The vertically integrated equations of momentum and mass conservation were used with appropriate boundary and initial conditions. The junction conditions were introduced by the time rates of change of energy and mass flux at the junction. A 'double sweep' approach was used in solving for the dynamics of flow. The method has several advantages in that the coefficient matrix in the solution system does not change as the model is stepped ahead in time. The Galerkin finite element model for flow in an inlet was found satisfactory considering the complex nature of the flow in a tidal inlet. (See also W80-05159) (Sims-ISWS)
W80-05203

**TIDAL CIRCULATION IN COASTAL SEAS,**
Rhode Island Univ., Kingston. Dept. of Ocean Engineering.
C. H. Beauchamp, and M. L. Spaulding.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 518-528, 1978. 9 Fig, 1 Tab, 15 Ref.

Descriptors: *Bays, *Tidal waters, *Water circulation, *Tides, *Model studies, *New England, Mathematical models, On-site data collections, Circulation, Tidal effects, Winds, Bathymetry, Currents(Water), Velocity, Coasts, Estuaries.

An application of Leendertse's multioperational finite difference scheme for solution to the two-dimensional, vertically integrated momentum and continuity equations has been made for tidal circulation in Long Island Sound, Block Island Sound, Rhode Island Sound, and Buzzards Bay (referred to as the Southern New England Intracoastal System). The circulation within the modeled region is predominantly forced by specification of tidal elevation along the large open boundary separating the system from New England shelf waters. No direct measurements of tidal elevation along this boundary exist, however, and an attempt to estimate this boundary condition has been made using range and phase at stations on the coast and limited tidal information for the shelf in the vicinity of the open boundary. The model was calibrated by comparing phase and range of tidal elevations obtained from the simulations with those measured at 46 locations within the modeled region. An optimal matching was accomplished by adjustment of bottom friction. Further comparison has been conducted using tidal current observations from several stations in Rhode Island Sound and a set of approximately 160 stations in Long Island and Block Island Sound. (See also W80-05159) (Sims-ISWS)
W80-05204

**VERIFICATION OF FIXED-BED ESTUARINE MODELS,**
Army Engineers Waterways Experiment Station, Vicksburg, MS.
M. J. Trawle, and R. F. Athow, Jr.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 583-590, 1978.

Descriptors: *Hydraulic models, *Estuaries, *Model studies, *Tidal waters, Currents(Water), Tidal effects, Shoals, Flow, Salinity, Calibrations, Fixed bed models, Model verification.

A fixed-bed estuarine model is a physical, hydraulic model of an estuary, molded in concrete, and scaled according to Froudian law. This type model is usually distorted. A typical scale is 1000 to 1 (prototype to model) horizontally, and 100 to 1 (prototype to model) vertically, resulting in a distortion ratio of 10 to 1. Fixed-bed estuarine models are designed to reproduce prototype water surface elevations, tidal currents, and salinities throughout the modeled area. Additionally, in such models design consideration is given to the reproduction of prototype sediment distribution within a portion of the modeled area. The worth of any model, physical or otherwise, is wholly dependent on the verification of the ability to produce within a reasonable degree of accuracy results which can be expected to occur in the prototype under given conditions. Verification of a fixed-bed estuarine model is generally accomplished in three phases: (1) hydraulic verification, which ensures that tidal elevations and phasing and current velocities and directions are in proper agreement with the prototype; (2) salinity verification, which ensures that salinity phenomena in the model correspond to those of the prototype for similar conditions of tide, ocean salinity, and freshwater inflow; and (3) fixed-bed sediment distribution verification, which assures acceptable reproduction of prototype sediment distribution. (See also W80-05159) (Humphreys-ISWS)
W80-05211

**FIELD VERIFICATION OF SEDIMENT TRANSPORT MODEL,**
Florida Univ., Gainesville. Dept. of Coastal and Oceanographic Engineering.
T. T. Chang, and Y. H. Wang.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 737-744, 1978. 2 Fig, 3 Tab, 5 Ref.

Descriptors: *On-site tests, *Sediment transport, *Model studies, *Coasts, Sediments, Movement, Littoral drift, Sands, Tracers, Methodology, Analysis, Analytical techniques, Mathematical models, Statistical methods, Model verification.

The purpose of this study was twofold: to investigate the sand transport rate under the wave and current action of the bayshore of a barrier island and to determine how different grain sizes and tracer injection positions affect the sand transportation rate. The sand-tracing method is used for determining the littoral transport rate. The data were analyzed by statistical methods. The effect of grain size on the sediment transport rate at different injection positions was analyzed by equating the grain size to the proportionality coefficient at different injection positions. The K' values were tested by the analysis of variance. It was concluded: (1) In this experiment the proportionality coefficient is not significantly influenced by the injection position and the grain size. The mathematical model has verified that the relationship between the immersed weight transport rate and wave and current parameters is linear. (2) The proportionality coefficient between the longshore transport rate and the wave and current parameters was determined by regression analysis. A regression line forcing through the origin incorporates most of the data points within the 95% confidence limits and accounts for 94% of the variation. (3) The proportional coefficient, K' = 0.18, on the bayshore of Santa Rosa barrier island is different from that derived by Komar. This difference may have resulted from the dissimilar transporting characteristics. On the bayside, wind may have played a noticeable role, while on the open coast the oblique breaking waves are prominent. (See also W80-05159) (Humphreys-ISWS)
W80-05228

**TWO-DIMENSIONAL TIDALLY AVERAGED ESTUARINE MODEL,**
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
W-S. Chu, and W. W-G. Yeh.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol 106, No HY4, Proceedings Paper 15345, p 501-518, April 1980. 8 Fig, 25 Ref, 2 Append. OWRT B-191-CAL(2).

Descriptors: *Estuaries, *Model studies, *Tidal waters, *Dispersion, Mathematical models, Salinity, Tidal energy, Average, Numerical analysis, Water quality, Hydrodynamics, Analytical techniques, Equations, Tidal effects, Hydraulics, Two dimensional model.

Two types of models have been used extensively in the studies of estuaries: (1) physical hydraulic models and (2) numerical models. This study deals with vertically averaged two-dimensional numerical models for estuarine hydrodynamics and salinity. The governing equations are the hydrodynamics equations coupled with the transport equation. The effect of the density gradient was included in the model which requires simultaneous solutions for all variables. The tidally averaged solutions and the associated numerical scheme were verified by solutions obtained from a corresponding transient model where long term integration was performed to reach a dynamic steady-state condition. The proposed model can be utilized to: (1) obtain dynamic steady-state solutions directly without performing long term integrations over time; and (2) serve as an efficient forward solution scheme for parameter identification, since parameters imbedded in the governing equations, such as the roughness coefficients, are essentially time-invariant. The tidally averaged model was derived under the assumption that amplitudes of the transient variables are small in magnitudes. (Humphreys-ISWS)
W80-05251

**THE OCCURRENCE OF BRYOPHYTES ON BRITISH SALTMARSHES,**
Cambridge Univ. (England). Botany School.
For primary bibliographic entry see Field 2I.
W80-05308

**FUNGI ASSOCIATED WITH THE ROOTS OF RED MANGROVE, RHIZOPHORA MANGLE,**
Hawaii Univ., Honolulu. Dept. of Botany.
For primary bibliographic entry see Field 2I.
W80-05312

**AIRBORNE MULTISPECTRAL SURVEY OF INTERTIDAL VEGETATION IN ALASKA,**
Environmental Research Inst. of Michigan, Ann Arbor.
For primary bibliographic entry see Field 2I.
W80-05313

**VEGETATIONAL DEVELOPMENT AND THE EFFECT OF GEESE ON VEGETATION AT LA PEROUSE BAY, MANITOBA,**
Toronto Univ. (Ontario). Dept. of Botany.
For primary bibliographic entry see Field 2I.
W80-05317

**BIOGENIC SEDIMENTARY STRUCTURES PRODUCED BY CRABS IN LAGOON MARGIN AND SALT MARSH ENVIRONMENTS NEAR BEAUFORT, NORTH CAROLINA,**
Mount Holyoke Coll., South Hadley, MA. Dept. of Geology.
For primary bibliographic entry see Field 2I.
W80-05320

**EXPERIMENTAL DEGRADATION OF DETRITUS MADE FROM THE SALT MARSH PLANTS SPARTINA ALTERNIFLORA LOISEL., SALICORNIA VIRGINICA L., AND JUNCUS ROEMERIANUS SCHEELE,**
Georgia Univ., Sapelo Island. Marine Inst.
For primary bibliographic entry see Field 2I.
W80-05321

**ACCUMULATION OF TIN BY MANGROVE SPECIES IN WEST MALAYSIA,**
Westfield Coll., London (England). Dept. of Botany and Biochemistry.
For primary bibliographic entry see Field 2I.
W80-05325

**ENVIRONMENTAL FACTORS IN RELATION TO THE SALT CONTENT OF SALICORNIA PACIFICA VAR. UTAHENSIS,**
Brigham Young Univ., Provo, UT. Dept. of Botany.
For primary bibliographic entry see Field 2I.
W80-05327

# 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

## 3A. Saline Water Conversion

**REVERSE OSMOSIS TECHNICAL MANUAL.**
Burns and Roe Industrial Services Corp., Paramus, NJ.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-186950, Price codes: A13 in paper copy, A01 in microfiche. Final Report OWRT TT/80 2 Prepared for the Office of Water Research and Technology, July 1979. 286 p. OWRT C-80155-S (No 8530)(1), 14-34-0001-8530.

Descriptors: *Reverse osmosis, *Semi-permeable membranes, *Membrane systems, Feedwater pretreatment, Salt rejection, Desalination, Seawater, Brackish water, Dissolved solids rejection.

A comprehensive design manual was compiled for reverse osmosis systems suitable for use by consulting engineers and others actively involved in water supply and improvement for municipal water systems. The manual includes chapters on semipermeable membranes, membrane module configurations, feedwater treatment, dissolved solids rejections, membrane productivity, systems design, system installation and operation, membrane applications, selected capital and annual costs and specifications and warranties. Appendices include miles-

tones in development of reverse osmosis, directory of manufacturers, water quality standards, performance calculations, glossary of terms, conversion tables and miscellaneous figures and tables. (Easton-OWRT)
W80-05155

## 3F. Conservation In Agriculture

**IRRIGATION MANAGEMENT -- A MECHANISM FOR SAVING ENERGY AND WATER,**
Nebraska Univ., Lincoln, Dept. of Agricultural Engineering.
P. Fischbach.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-190614, Price codes: A09 in paper copy, A01 in microfiche. Project Completion Report, May 1980. 188 p. OWRT B-033-NEB(1), 14-31-0001-5137.

Descriptors: *Irrigation design, *Water conservation, *Energy conservation, *Irrigation efficiency, *Agriculture, Water management(Applied), Irrigation systems, Furrow systems, Water requirements, Nebraska.

Research was conducted to determine irrigation management practices on the various soil textures in Nebraska. The basic objective was to design and select irrigation systems to minimize water and energy requirements. To meet this objective, improved irrigation practices were investigated for more efficient use of water and energy resources. Research has indicated that irrigating at maximum non-erosive stream size and automating the furrow irrigation system, one can reduce the irrigation set time and amount of water applied to acceptable levels. This design criteria substantially increases the efficiency of water and energy used. Research has also shown that the selection of various furrow opening and furrow smoothing practices influences the amount of water applied and should be selected according to the soils infiltration characteristics. Applying a maximum two-inch application of water is recommended during the first irrigation and up to a three-inch application for subsequent irrigations. Research indicates that various irrigation scheduling methods may be used to make efficient use of water and energy which may improve these practices. A state-wide program of technology transfer by the Cooperative Extension Service was developed to disseminate research results to farmers, agricultural consultants and other groups who may make immediate application of results.
W80-05249

# 4. WATER QUANTITY MANAGEMENT AND CONTROL

## 4A. Control Of Water On The Surface

**AN INTERACTIVE SIMULATION OF PUMPED STORAGE RESERVOIR SYSTEMS,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
W. F. Calhoun, E. F. Benfield, and D. N. Contractor.
Water Resources Bulletin, Vol 16, No 1, p 63-68, February 1980. 7 Fig, 14 Ref.

Descriptors: *Reservoirs, *Pumped storage, *Water temperature, *Model studies, Mathematical models, Computer models, Simulation analysis, Powerplants, Electric powerplants, Rivers, Temperature, Computer programs, Evaluation.

A combination pumped storage reservoir system was simulated by modifying the WRE deep reservoir model. Each of the two reservoirs was described by a copy of the WRE model program, the two programs were converted into subroutines and were called upon alternately by a main program. Operationally, the contributing reservoir, i.e., the reservoir from which flow was discharged, was simulated for one execution interval (1 hour), followed by simulating the receiving reservoir for the same execution interval. The main program directed the discharge temperature of the contributing reservoir for each execution interval as input for simulating the receiving reservoir. The two subroutines were run in this interactive mode for a simulation period of one year. Two simulations, labeled 'Pump' and 'Net', were effected and differed basically in the distribution of flow volumes exchanged between the reservoirs. In the 'Pump' simulation the total hourly flow volumes were distributed into appropriate horizontal layers of the lakes as determined by temperature-density relationships, i.e., the pumped discharges were distributed into the upper lake and the generation discharges were distributed into the lower lake. In the 'Net' simulation only the net daily discharges (daily difference between pump-back and generation at the upper dam), distributed uniformly over 24 hours, were mixed into the horizontal layers of the two lakes. Both simulations produced annual thermal regimes that were apparently within reason for the geographical area and the nature of the input data. However, neither accurately reflected a generalized condition for the reservoirs because the 'Pump' simulation reflected conditions in the forebay and tailrace of the Upper dam while the 'Net' simulation reflected conditions of the remaining parts of the reservoirs. (Sims-ISWS)
W80-05142

**CONTROL OF UNSTEADY FREE-SURFACE FLOW WITH GATES,**
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W80-05232

**RUNOFF SIMULATION MODEL: APPLICATION AND VERIFICATION,**
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 2A.
W80-05240

**COMPARISON OF STORMWATER DETENTION POLICIES,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W80-05241

**A DIGITAL OVERLAY TECHNIQUE FOR EVALUATION OF POTENTIAL INFILTRATION AND RECHARGE,**
University of South Florida, Tampa. Coll. of Engineering.
M. W. Anderson, and R. F. Giovannelli.
Water Resources Bulletin, Vol 16, No 1, p 93-99, February 1980. 5 Fig, 1 Tab, 2 Ref.

Descriptors: *Groundwater recharge, *Infiltration, *Mapping, *Land use, *Planning, *Florida, Computer models, Equations, Land development, Runoff, Soil types, Water levels, Water table, Potentiometric level, Hydraulic properties, Overlay mapping.

A common problem encountered during regional planning and development of groundwater dependent communities is the difficulty in deciding which areas should be preserved for aquifer recharge purposes. This paper described the development and application of a digital overlay technique for objective evaluation and ranking of potential infiltration and potential recharge areas. Equations were developed which relate the hydrologic parameters pertaining to infiltration and recharge in a surface aquifer-confined aquifer system. These equations make use of discrete data, yet by application in a digital overlay technique results are obtained in the form of spatial distributions in order for regional trends and conditions to be examined. An application of this procedure to the 551,000 acre region of central Florida, known as the Green Swamp, was discussed. The results were presented in the form of computer-generated maps which identify and rank areas of potential recharge to the aquifer system. (Visocky-ISWS)
W80-05261

## 4B. Groundwater Management

**THE ECONOMIC CONSEQUENCES OF IRRIGATING CORN ON FINE TEXTURED SOILS IN THE HUMID MIDWEST,**
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W80-05102

**A PLAN TO STUDY THE AQUIFER SYSTEM OF THE CENTRAL VALLEY OF CALIFORNIA,**
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 6A.
W80-05296

**CONTRIBUTION OF GROUNDWATER MODELING TO PLANNING,**
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 6A.
W80-05300

**MANAGING A LIMITED RESOURCE: THE POLITICAL CONSTRAINTS ON WATER POLICY IN THE FOUR-CORNERS STATES,**
Arizona Univ., Tucson.
For primary bibliographic entry see Field 6E.
W80-05370

**GEOTHERMAL DEVELOPMENT AND WESTERN WATER LAW,**
O'Melveny and Myers, Los Angeles, CA.
For primary bibliographic entry see Field 6E.
W80-05372

## 4C. Effects On Water Of Man's Non-Water Activities

**AN OPTIMIZATION TECHNIQUE FOR A MATHEMATICAL URBAN RUNOFF MODEL,**
Howard, Needles, Tammen and Bergendoff, Minneapolis, MN.
C. S. Chu, and C. E. Bowers.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 120-128, 1978. 7 Fig, 1 Tab, 16 Ref, 1 Append.

Descriptors: *Optimization, *Model studies, *Urban runoff, Urban hydrology, Mathematical models, Analytical techniques, Infiltration, Hydrographs, Mathematical studies, Computer models.

The purpose of the study was to develop a simple mathematical urban runoff model and, along with it, an automatic optimization technique. The optimization technique can assist the user in determining the 'best' set of input parameters to reproduce an observed hydrograph. A modified Holtan's infiltration equation based on soil moisture content was used to compute the infiltration rate. A simple Soil Conservation Service triangular unit hydrograph procedure was used to obtain the runoff hydrograph. A routing procedure has not, as yet, been included in the model. Seven available optimization techniques were tested in order to select the best optimization technique for the model. It was found that the BOX-COMPLEX method produced consistently good results for five randomly chosen initial starting points. Other 'Gradient' methods did not perform as well. Improvement of BOX-COMPLEX method was attempted by (1) changing the values of coefficients and the number of operations and (2) by adding expansion and shrinkage operations. It was found that the two basic operations, reflection and contraction, with proper coefficient values not only produced good results but also retained the simple structure of the

BOX-COMPLEX method. The reflection and contraction coefficients were 2.0 and 0.5, respectively. The model was applied to the Oakdale Avenue Drainage Basins in Chicago. The agreement between the observed and the calculated hydrographs achieved by the proposed model, for a storm of July 2, 1960, was excellent in both timing and magnitude of the peak flow. (See also W80-05159) (Humphreys-ISWS)
W80-05169

**RECONNAISSANCE ASSESSMENT OF EROSION AND SEDIMENTATION IN THE CANADA DE LOS ALAMOS BASIN, LOS ANGELES AND VENTURA COUNTIES, CALIFORNIA,**
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 2J.
W80-05305

**STOCHASTIC ANALYSIS OF ANNUAL RAINFALL AFFECTED BY URBANIZATION,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 2B.
W80-05331

**SURFACE MINING AND THE HYDROLOGIC BALANCE,**
Northeastern Forest Experiment Station, Berea, KY.
W. R. Curtis.
Mining Congress Journal, p 35-40, July 1979. 3 Fig, 3 Tab, 17 Ref.

Descriptors: *Hydrology, *Strip mines, *Peak flow, *Sedimentation, *Erosion, Effects, Storm runoff, Land reclamation, Flow rates, Kentucky, West Virginia, Eastern Kentucky, Southern West Virginia.

Research by the U. S. Forest Service at Berea, Kentucky, has shown that surface mining results in increases in storm peak flows during and immediately after mining, but that peaks may be significantly lower after reclamation is completed. Data from experimental sites in Breathitt County, Kentucky, and Raleigh County, West Virginia, during major rainstorms on 4 April 1977 and 8, 9, and 10 December 1978 showed that streamflow from surface-mined watersheds peaked lower than that from adjacent or nearby unmined watersheds. Impoundments on surface-mine lands can be effective in controlling runoff and erosion provided the ponds are properly constructed. Erosion and subsequent sedimentation are greatest during early stages of mining but diminish rapidly as the land is reclaimed and vegetation growth progresses.
W80-05334

**THE URBAN COAST FROM A NATIONAL PERSPECTIVE,**
National Oceanic and Atmospheric Administration, Office of Coastal Zone Management.
For primary bibliographic entry see Field 6E.
W80-05363

**THE LOST WATERFRONT OF NEW YORK,**
New York Univ., NY. Graduate School of Public Administration.
For primary bibliographic entry see Field 6E.
W80-05364

**ENERGY FACILITY SITING IN THE URBAN COASTAL ZONE: COMPATIBLE OR NOT,**
Princeton Univ., NJ.
For primary bibliographic entry see Field 6E.
W80-05365

**COASTAL ZONE MANAGEMENT: THE FIRST FIVE YEARS AND BEYOND,**
National Oceanic and Atmospheric Administration, Washington, DC.
For primary bibliographic entry see Field 6E.
W80-05366

**A PETROLEUM INDUSTRY PERSPECTIVE ON FEDERAL COASTAL ZONE MANAGEMENT,**
American Petroleum Inst., Washington, DC.
For primary bibliographic entry see Field 6E.
W80-05367

**UNRESOLVED ISSUES OF COASTAL ZONE MANAGEMENT,**
Rose, Schmidt, Dixon, Hasley, Whyte and Hardesty, Washington, DC.
For primary bibliographic entry see Field 6E.
W80-05368

**COASTAL LAND MANAGEMENT IN CALIFORNIA,**
Houston Univ., TX.
For primary bibliographic entry see Field 6E.
W80-05378

## 4D. Watershed Protection

**ESTIMATING THE C FACTOR IN THE UNIVERSAL SOIL LOSS EQUATION FOR LANDSCAPED SLOPES,**
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W80-05147

**ESTIMATING THE C FACTOR IN THE UNIVERSAL SOIL LOSS EQUATION FOR LANDSCAPED SLOPES: A FIELD RATING SYSTEM,**
Pennsylvania State Univ., University Park. Dept. of Agronomy.
For primary bibliographic entry see Field 2J.
W80-05148

**HYDROSEEDING FOREST ROADSIDES IN BRITISH COLUMBIA FOR EROSION CONTROL,**
British Columbia Univ., Vancouver. Dept. of Soil Science.
W. W. Carr, and T. M. Ballard.
Journal of Soil and Water Conservation, Vol 35, No 1, p 33-35, January-February 1980. 5 Tab, 9 Ref.

Descriptors: *Vegetation establishment, *Erosion control, *Road construction, *Slopes, On-site investigations, Grasses, Legumes, Forests, Roads, Erosion, Construction, Vegetation effects, Canada, British Columbia, *Hydroseeding.

Hydroseeding trials on forest roadside slopes at two Vancouver Island sites showed that a single application of both seed and fertilizer was as effective as sequential application of seed and fertilizer. Mulching proved unnecessary. Untreated plots had no plant cover. Soil eroded to an average depth of 2.3 centimeters between September 1976 and April 1977, an estimated soil loss of 345 cubic meters per kilometer of road. Plant cover on treated plots, which averaged 65%, trapped soil eroded from upslope. (Sims-ISWS)
W80-05149

# 5. WATER QUALITY MANAGEMENT AND PROTECTION

## 5A. Identification Of Pollutants

**REQUIREMENTS OF STATE REGULATORY AGENCIES FOR MONITORING GROUNDWATER QUALITY AT WASTE DISPOSAL SITES,**
Minnesota Pollution Control Agency, Minneapolis.
T. P. Clark, and G. V. Sabel.
Ground Water, Vol 18, No 2, p 168-174, March-April 1980. 1 Fig, 2 Tab, 6 Ref.

Descriptors: *Groundwater, *Water quality, *Waste disposal, *Monitoring, Pollutants, Pollutant identification, Chemicals, Sampling, Surveys, Observation wells, Water pollution, Water pollution control, Law enforcement.

A survey of the requirements of State regulatory agencies responsible for monitoring groundwater quality at waste disposal sites was conducted in order to gain a concise profile of monitoring practices across the country, and also to provide the basis for a monitoring manual to serve as technical background and guidance for the citizens of Minnesota. The survey considered a variety of topics including the regulatory framework for requiring monitoring, chemical parameters analyzed, recommended methods of monitoring well construction and sample collection, laboratory quality control, data interpretation, and postoperational monitoring requirements. The survey showed that most State monitoring programs are in their infancy. Many States, however, are beginning to devote serious effort and manpower commitments to the development of monitoring programs, although there is considerable divergence of opinion regarding how these programs should be conducted. Federal legislation establishing minimum performance criteria instead of detailed operating requirements for waste disposal sites will increase the need for sound water monitoring programs at these sites in the future. (Sims-ISWS)
W80-05129

**COMPARATIVE NUTRIENT DYNAMICS OF A MARSH-MUDFLAT ECOSYSTEM,**
Connecticut Univ., Groton. Marine Sciences Inst.
For primary bibliographic entry see Field 5B.
W80-05131

**WATER QUALITY TRAP EFFICIENCY OF STORM WATER MANAGEMENT BASINS,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W80-05139

**HYDROTHERMAL ANALYSES USING COMPUTER MODELING AND FIELD STUDIES,**
Tennessee Valley Authority, Norris.
W. R. Waldrop.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 38-43, 1978. 3 Fig, 1 Ref.

Descriptors: *Hydrothermal studies, *Heated water, *Reservoirs, *On-site investigations, *Tennessee, Spatial distribution, Water temperature, Measurement, Model studies, Isotherms, Calibrations, Diffusion, On-site data collections, Analysis.

The procedures employed by TVA for obtaining field data, a brief discussion of the features of a three-dimensional finite-difference model used for simulations, and an example of model verification were presented. Results from the three-dimensional model were needed for an environmental evaluation of the submerged intake and surface discharge of condenser cooling water of the TVA Gallatin Steam Plant in central Tennessee. Prior to using the model to compute flow and temperature patterns under extreme conditions, the model was used to simulate a relatively high flow condition for which field data had been obtained. The comparison of measured and computed isotherms at a depth of 0.15 meters was presented. The results compare quite well in the main channel and are adequate in the shallow region near the right bank. Better agreement could have been achieved in this region by increasing the resolution, but the grid spacing was chosen such that three-fourths of the grid points were placed upstream of the discharge channel to evaluate flows and temperatures in environmentally sensitive areas during very low flows. (See also W80-05159) (Humphreys-ISWS)
W80-05161

**MEASURING EFFLUENT PLUMES,**
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.

T. Green, J. A. Hoopes, F. L. Scarpace, J. R. Villemonte, and R. P. Madding.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 44-53, 1978. 1 Tab, 35 Ref.

Descriptors: *Lakes, *Rivers, *Effluents, *Wisconsin, On-site investigations, Water temperature, Turbidity, Spatial distribution, Heated water, Instrumentation, Sewage effluents, Industrial wastes, Remote sensing, Methodology, Reviews, Measurement, Plumes, Thermal plumes.

The University of Wisconsin at Madison has been measuring various aspects of effluent surface plumes into rivers, small lakes, and Great Lakes for over a decade. Some of this work has been aimed at developing measurement techniques, some at eliciting the fluid mechanics of the phenomenon, and some at formulating numerical models either generally applicable or directly applicable to the particular site. This paper is a review of the highlights of that work, together with a fairly complete list of references in which more details of the work can be found. The plumes studied were subdivided by the type of receiving water body, and according to whether the effluent is characterized mainly by its temperature (e.g., the discharged cooling water from a power plant) or by some other property (e.g., the effluent from a paper company). (See also W80-05159) (Humphreys-ISWS)
W80-05162

**A THREE DIMENSIONAL THERMAL PLUME MODEL,**
Cooper Union, New York.
J. C. Cataldo, R. R. Zavesky, and A. S. Goodman.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 54-60, 1978. 2 Fig, 4 Ref.

Descriptors: *Hydrothermal studies, *Reservoirs, *Isotherms, *Model studies, Mathematical models, Heated water, Forecasting, Spatial distribution, Discharge(Water), Water temperature, On-site investigations, Thermal plumes, Three-dimensional plume.

Presently, there are two techniques used to measure plume temperatures: (1) boats with in situ, temperature-sensing instrumentation, and (2) airborne, thermal, infrared, detection instrumentation. The aerial, infrared-monitoring offers a truly synoptic picture of the surface temperature, whereas the boat technique, because of the time needed for measurements, provides a time-distorted picture of the plume. A phenomenological model to predict both surface and subsurface temperatures from given discharge and receiving water characteristics was presented. The only parameters needed for the model are the plant discharge conditions and receiving water characteristics. The model, at this time, is restricted to surface discharges into zero or mild receiving water currents. The procedure may easily be extended to include receiving waters with strong cross-flows when sufficient triaxial, thermal-plume data become available to calibrate the model. A total of 19 triaxial field-surveys from five power plants were used to develop and calibrate the model. (See also W80-05159) (Humphreys-ISWS)
W80-05163

**VERIFICATION OF AN ESTUARINE MODEL FOR APALACHICOLA BAY, FLORIDA,**
Florida Univ., Gainesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W80-05179

**MODIFYING AUTOMATED PUMPING SAMPLERS FOR USE IN SMALL MOUNTAIN STREAMS,**
Oregon State Univ., Corvallis. School of Forestry.
R. L. Beschta.
Water Resources Bulletin, Vol 16, No 1, p 137-138, February 1980. 2 Fig.

Descriptors: *Water quality, *Sampling, *Streams, *Equipment, *Oregon, Monitoring, Runoff, Streamflow, Pollutants, Water pollution, Mountains, Sampling equipment, Pumping samplers.

Two modifications to automated pumping samplers improve discrete sampling during high flow events in small mountain streams. One modification entails mounting the intake nozzle on a bent, free-swinging metal rod supported in midstream. This allows sampling in midstream yet prevents the buildup of floatable organic debris that otherwise would cause the intake to fail. On the lower end of the rod, dynamic forces exerted by the stream keep the intake submerged over diverse flow conditions. The second modification consists of a magnetic switching device that automatically activates the pumping sampler at any preset stage on the rising limb of a storm hydrograph. The pumping sampler then remains on to collect one sample per hour which allows field crews sufficient time to change bottles before the sampler fills its 28-bottle capacity. This device improves the capability to sample frequently at fixed intervals, yet with minimal maintenance between runoff events. It also ensures sample collection during the rising limb of the hydrograph when flow and sediment concentrations are rapidly changing. Both modifications have improved data collection during periods of storm runoff. (Sims-ISWS)
W80-05256

**USING ARTIFICIAL STREAMS TO EVALUATE PERTURBATION EFFECTS ON AUFWUCHS STRUCTURE AND FUNCTION,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
J. R. Clark, J. H. Rodgers, Jr., K. L. Dickson, and J. Cairns, Jr.
Water Resources Bulletin, Vol 16, No 1, p 100-104, February 1980. 3 Fig, 1 Tab, 30 Ref. DOE E-(40-1)-4939.

Descriptors: *Periphyton, *Biological communities, *Streams, *Laboratory tests, Biomass, Water circulation, Velocity, Flow, Equipment, Facilities, Research facilities, Biology, Ecosystems, *Artificial streams, Perturbation effects.

Artificial streams can assist in assessing the potential impact of pollutants on the structure and function of aquatic communities. While most artificial streams are constructed within a controlled environment or are maintained by recirculating water, the authors constructed a series of artificial streams along a river bank using river water on a once-through basis. This system was used to develop and test methods for structural and functional analyses of Aufwuchs communities. Only the flow rate and stream depth were controlled while individual streams were perturbed to obtain communities of altered ecological condition. This experimental system provided a relatively inexpensive series of treated and untreated streams which allowed an evaluation and comparison of methods using communities under various stressed and nonstressed conditions. Without the stabilizing effects of a controlled atmosphere or recirculating water, the authors' approach demonstrated a degree of variability which approached that of the river. It was inferred that the Aufwuchs community present in the artificial streams maintained a high degree of structural complexity and functional dynamism, providing a strong test of the methods employed and an opportunity to examine current ecological theory. (Sims-ISWS)
W80-05260

**COLIFORMS AND WATER QUALITY: USE OF DATA IN PROJECT DESIGN AND OPERATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5B.
W80-05262

**CHLORINATED ORGANIC RESIDUES IN FISH, WATER, AND PRECIPITATION FROM THE VICINITY OF ISLE ROYALE, LAKE SUPERIOR,**
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
For primary bibliographic entry see Field 2H.
W80-05273

**TRANSPLANTING AQUATIC BRYOPHYTES TO ASSESS RIVER POLLUTION,**
University Coll., Cardiff (Wales). Dept. of Botany.
K. Benson-Evans, and P. F. Williams.
Journal of Brycology, Vol 9, p 81-91, 1976. 3 Fig, 3 Tab, 19 Ref.

Descriptors: *Rivers, *Mosses, *Water pollution, *Bioindicators, Vegetation effects, Environmental effects, Bioassay, Water pollution effects, Aquatic plants.

Literature dealing with the use of bryophytes for water quality assessment is briefly reviewed. Reasons are presented for the selection of the two bryophyte species, Eurhnchium riparioides and Fontinalis antipyretica, used in transplantation experiments. Results show that the breakdown of the two species, exposed on the river Ebbw Fawr, reflect improvements in water quality both downstream of the main source of pollution as a result of dilution and precipitation of pollutants, and over a period of four years as a result of improved effluent treatments. (Steiner-Mass)
W80-05311

**ACCUMULATION OF TIN BY MANGROVE SPECIES IN WEST MALAYSIA,**
Westfield Coll., London (England). Dept. of Botany and Biochemistry.
For primary bibliographic entry see Field 2I.
W80-05325

**DATA PROCESSING AND ANALYSIS FROM H-F RADAR DATA OBTAINED IN COOK INLET ALASKA DURING SUMMERS 1977 AND 1978,**
National Oceanic and Atmospheric Administration, Rockville, MD. Wave Propagation Lab.
D. E. Barrick, S. Frisch, and R. Weber.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 1-4, 18-114, October 1979. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Data processing, *Radar, *Currents(Water), Baseline studies, Environmental effects, Water pollution, Resources development, Movement, Path of pollutants, Alaska, *Outer Continental Shelf, Gulf of Alaska, Petroleum development.

During the summer of 1977 the H-F Doppler surface current radar system was deployed in lower Cook Inlet, Alaska at Anchor Point and Seldovia. Several time series of data were collected during the deployment period. A representative 24-hour data set has been extensively analyzed. During the summer of 1978, a radar system was successfully operated in western lower Cook Inlet, Alaska, for a period of two weeks. About 8 days of data were collected at this time. The radar sites were located at Cape Douglas and Augustine Island for these experiments. These data have been processed and current vector maps have been plotted and included in this report. (Sinha-OEIS)
W80-05337

**A NEW TECHNIQUE FOR MEASURING TIDAL CURRENTS USING A TWO-SITE HF DOPPLER RADAR SYSTEM,**
National Oceanic and Atmospheric Administration, Rockville, MD. Wave Propagation Lab.
A. S. Frisch, and B. L. Weber.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 5-17, October 1979. 13 Ref. NOAA, Environmental Research Laboratories, Outer Con-

tinental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Tidal effects, *Radar, *Currents(Water), Offshore platforms, Water pollution effects, Resources development, Environmental effects, Alaska, Oil pollution, Movement, *Outer Continental Shelf, Tidal currents, Nearshore environment, Doppler radar, Gulf of Alaska, Petroleum development.

Surface currents were measured using a newly developed H-F (High Frequency) Doppler radar technique. The system was operated in lower Cook Inlet, Alaska in July, 1977. During one particular day the radar data collected every 30 minutes for 24 hours was analyzed. By least squares fitting these data to two of the dominate tidal periods, 12.31 and 24.6 hours, the spatial distribution of the tidal currents for each of these two periods were determined. In addition, the spatial distribution of the mean surface currents were determined for the 24 hour period. Analysis of the data shows that near Kachemak Bay, there is a distint difference of the east-west component of tidal flow compared to regions further from Kachemak. The results demonstrate the use of H-F radar techniques for resolving spatial and temporal currents which affect the nearshore environment. In those near-shore regions where the tidal currents dominate, the radar measurements, in conjunction with the tidal analysis, actually provides sub-surface currents which are important for stress considerations of off-shore oil platforms. (Sinha-OEIS)
W80-05338

**THE INTERACTION OF OIL WITH SEA ICE IN THE ARCTIC OCEAN,**
Washington Univ., Seattle. Dept. of Oceanography.
S. Martin.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 171-180, October 1979. 2 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-5-022-67.

Descriptors: *Sea ice, *Water pollution effects, *Oil spills, Movement, Environmental effects, Arctic Ocean, Baseline studies, Resources development, Alaska, *Outer Continental Shelf, Petroleum development, Grease ice, Pancake ice.

To understand how spilled oil might interact with the various kinds of ice in the Beaufort, Bering and Chukchi Seas, field traverses were done in these regions with particular emphasis on ice types which have previously not been studied. These include grease and pancake ice in Norton and Kotzebue Sound, and most recently a field investigation of the ice plumes which form at the pack ice edge in the Bering Sea. In the laboratory experiments have been performed on how spilled oil interacts with grease ice, pancake ice, and simulated multi-year ice. (Sinha-OEIS)
W80-05340

**DYNAMICS OF NEAR-SHORE ICE,**
Cold Regions Research and Engineering Lab., Hanover, NH.
A. Kovacs, and W. Weeks.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 181-207, October 1979. 8 Fig, 3 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-01-5-022-1651.

Descriptors: *Sea ice, *Remote sensing, *Hazards, *Oil spills, *Movement, Engineering, Environmental effects, Baseline studies, Arctic Ocean, Water pollution, *Outer Continental Shelf, Fast ice, Petroleum development.

A knowledge of motion, deformation and physical characteristics of both the near-shore pack ice and the fast ice is essential to adequately designing and estimating the hazards associated with a variety of engineering options that may be considered for offshore operations in the near coastal areas of the Beaufort and Chukchi Seas. The present program contributes directly to the solution of this general class of engineering problems in that it will provide much of the geophysical and engineering data upon which sound engineering and regulatory decisions can be made. Interest in observing and developing methods to predict the drift of pack ice through the Bering Strait is linked to the fact that ice flow through the Straits would be a key mechanism in dispersing an oil spill occurring along the coastal areas of the Beaufort and Chukchi Seas. A remote sensing program provides basic information on the distribution of ice types and features and in particular ridges required as one aspect of a risk analysis for the construction of an offshore drilling platform sited on the edge of the Arctic Ocean. (Sinha-OEIS)
W80-05341

**CURRENT MEASUREMENTS IN POSSIBLE DISPERSAL REGIONS OF THE BEAUFORT SEA,**
Washington Univ., Seattle. Dept. of Oceanography.
K. Aagaard.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 208-231, October 1979. 7 Fig, 5 Tab. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-5-022-67.

Descriptors: *Currents(Water), *Dispersion, *Water pollution, *Ocean circulation, Oil spills, Resources development, Environmental effects, Arctic Ocean, Alaska, *Outer Continental Shelf, Beaufort Sea, Petroleum development.

The objective of this work has been to obtain long-term Eulerian time series of currents at selected locations on the outer shelf of the Beaufort Sea. Such measurements are necessary to describe and understand the circulation on the shelf and the exchange between the shelf and the deep Arctic Ocean. The significance of these results to the dispersion of plankton, pollutants, and substances of geological and biological consequence (below about 60 m) is as follows: (1) Material trajectories will nearly follow isobaths; (2) Over a period anywhere from 1-10 days, displacement may be either eastward or westward, and the magnitude of such displacement can exceed 40 km over 24 hours; (3) On time scales exceeding about one month, the net displacement will be westward, with mean speeds corresponding to typical monthly displacements in the range of 100-250 km; (4) Materials can also move on- and offshore on time scales of a few days. Such movements likely involve vertical displacements of several hundred meters; and (5) The shelf is an energetic and variable environment even in winter. (Sinha-OEIS)
W80-05342

**NORTHWEST GULF OF ALASKA SHELF CIRCULATION,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
R. D. Muench, J. D. Schumacher, and R. Sillcox.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 232-248, October 1979. 8 Fig, 1 Tab, 14 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Currents(Water), *Dispersion, *Diffusion, Water pollution effects, Sediment transport, Oil spills, Baseline studies, Resources development, Alaska, Path of pollutants, Water circulation, *Outer Continental Shelf, Gulf of Alaska, Petroleum development.

The objective of this work is to relate oceanic advective and diffusive processes to potential pollution problems due to OCS petroleum development. This is accomplished through field activities including moored current measurements and water mass analysis using temperature and salinity observations. The regions being considered include the northwest Gulf of Alaska continental shelf west from about the longitude of Seward, Alaska to Unimak Pass and extends offshore to the outer boundary of the Alaskan Stream some 100 km off Kodiak Island. This study provides estimates of the fields of water motion which exert primary control over trajectories of spilled oil and over diffusion processes along the trajectories. Oil introduced into the environment via long-term or chronic leakage is more likely to be dispersed throughout the water column and, possibly, scavenged by suspended particulate matter. The problem then becomes one of understanding net transport of suspended matter, a process related to advective and diffusive fields within the water column. Understanding of these processes requires an analysis of the velocity field and its driving mechanisms. (Sinha-OEIS)
W80-05343

**BRISTOL BAY OCEANOGRAPHIC PROCESSES (B-BOP),**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
R. L. Charnell, J. D. Schumacher, L. K. Coachman, and T. H. Kinder.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 249-319, October 1979. 27 Fig, 4 Tab, 40 Ref, 2 Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado

Descriptors: *Oceanography, *Currents(Water), *Tidal effects, *Hazards, Oil pollution, Baseline studies, Environmental effects, Water pollution effects, Alaska, Flow, *Outer Continental Shelf, *Bristol Bay(AK), Physical oceanography, Petroleum development.

The current reporting period covers the final experiments specifically conceived to address OCSEAP objectives in Bristol Bay and includes data analysis which will lead to the formulation of a comprehensive understanding of physical oceanographic processes occurring within Bristol Bay. Field efforts during this period were directed toward two objectives: the general nature of flow in Bristol Bay and detailed experiments of the dynamics to two structural fronts and their relation to: (1) the biology of the area and (2) an examination of the velocity field across and along the front. Analysis efforts have continued toward elucidating such phenomena as: fine structure, fronts, tides and tidal currents, eddy circulation off the shelf, and the mean and low frequency flow through the area. These efforts should lead to a reasonable synthesis of the regional physical oceanography, and its influence on the petroleum development hazard assessment. (Sinha-OEIS)
W80-05344

**CIRCULATION AND WATER MASSES IN THE GULF OF ALASKA,**
Alaska Univ., Fairbanks. Inst. of Marine Science.
T. C. Royer.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 320-383, October 1979. 19 Fig, 1 Tab, 2 Ref, Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-5-022-56.

Descriptors: *Oceanography, *Water circulation, *Paths of pollutants, *Oil spills, Environmental effects, Water pollution, Alaska, Resources development, *Outer Continental Shelf, *Gulf of Alaska, Water masses, Petroleum development.

Since the inception of the OCSEAP-NEGOA program, the knowledge of the physical oceanog-

raphy, in particular circulation and water masses, has evolved from the point where the annual cycle was marginally described to some of the physical mechanisms which control the annual cycle. The practical implications of this evolution in the case of OCSEAP is to better predict the shelf circulation and hence the possible trajectories that oil spills would follow. The improved understanding of the physical mechanisms which control the circulation allow predictions to be made from observational periods. The focus has been on mesoscale driving mechanisms in the past year's research. The mechanisms for driving the shelf circulation, such as wind stress, precipitation, runoff, and offshore circulation have been more clearly identified. This has lead to a detailed treatment of winds at Middleton Island and the hydrology for the southcoast region. Abstracts of papers submitted, presented or published are included in this report. (Sinha-OEIS)
W80-05345

**NEAR-SHORE METEOROLOGY,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
R. M. Reynolds, S. A. Macklin, and B. A. Walter.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 384-401, October 1979. 2 Fig, 2 Tab. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Weather patterns, *Winds, *Meteorology, Paths of pollutants, Oil pollution, Resources development, Water pollution, Baseline studies, Environmental effects, Alaska, *Outer Continental Shelf, Gulf of Alaska, Wind stress, Petroleum development.

The objective of this study is to define the dominant mesoscale features in four specific coastal regions, Albatross Banks, Kiliuda Bay, Lower Cook Inlet, and Hinchinbrook Entrance. A thorough knowledge of coastal wind conditions is an important ingredient to responsible offshore industrial development. Surface winds strongly affect both mean water circulations and the trajectories of surface contaminants. The work is aimed at defining which processes are active in modifying the wind field along the coast of Alaska, how prevalent they are, and how far offshore they act. All available meteorological data is utilized in developing as complete a description as possible for the four regions. The work is principally a comparison of the observed flow field and larger scale forcing, with some consideration to the energetics of the planetary boundary layer. Both ends of the spectrum are important in such a study due to the juxtaposition of different modifying processes. (Sinha-OEIS)
W80-05346

**OBSERVATIONS OF MESOSCALE WINDS IN LOWER COOK INLET, ALASKA - MARCH 1978,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
S. A. Macklin.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 402-433, October 1979. 11 Fig, 2 Tab, 17 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Winds, *Climatology, *Baseline studies, Environmental effects, Water pollution effects, Oil spills, Hazards, Alaska, Resources development, Paths of pollutants, *Outer Continental Shelf, Cook Inlet(AK), Petroleum development.

Surface wind data were collected and analyzed for the lower Cook Inlet region in March 1978. The dominant surface air circulation is due to pressure gradient forcing along two nearly orthogonal orographic channels. As much as 84% of surface air movement observed in lower Cook Inlet can be explained in terms of this flow. Additional mesoscale flows of katabatic and lee wave nature were identified at Kachemak Bay, Cape Douglas and Augustine Island. With the advent of oil exploration in lower Cook Inlet and the accompanying hazard of oil spills, knowledge of Cook Inlet air movement in response to large and small scale meteorological forcing is important. An accurate knowledge of coastal winds is also important in determining shallow water circulation in estuaries and on the continental shelf in charting the distribution of marine larval species and in providing accurate wind information to both aeronautical and marine navigators. (Sinha-OEIS)
W80-05347

**THE RESPONSE OF COASTAL WINDS AT ALBATROSS BANKS, LOWER COOK INLET, AND HINCHINBROOK ENTRANCE TO A PASSING SYNOPTIC DISTURBANCE - PRELIMINARY ANALYSIS,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
S. A. Macklin.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 491-504, October 1979. 4 Fig. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Storms, *Winds, *Extratropical cyclones, *Oil spills, Hazards, Paths of pollutants, Resources development, Environmental effects, Water pollution, Alaska, Cook Inlet(AK), *Outer Continental Shelf, Weather conditions, Gulf of Alaska, Petroleum development.

This study relates coastal wind fields in three proposed oil lease and transport areas - lower Cook Inlet, Albatross Banks, and Hinchinbrook Entrance - to the passage of a typical extratropical cyclone. The possibility of inferring winds during an oil spill with such a synoptic scenario is investigated. Surface winds in these three coastal areas are explained in terms of synoptic characteristics of a mid-latitude cyclone. This storm influenced the study regions over the period 11 March to 13 March 1978 as it moved north out of the Pacific Ocean across the Aleutian Islands and into the Bering Sea. Maximum observed surface winds coincided with passage of an occluded front associated with the storm. Coastal winds in lower Cook Inlet and Hinchinbrook Entrance were dominated by orography. Winds over the Albatross Banks were observed to be a direct result of synoptic forcing alone. (Sinha-OEIS)
W80-05348

**MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA,**
Rand Corp., Santa Monica, CA.
J. J. Leendertse, and S. K. Liu.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 547-560, October 1979. 9 Fig, 2 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Model studies, *Currents(Water), *Tides, *Paths of pollutants, Oil spills, Water pollution effects, Environmental effects, Baseline studies, Alaska, Resources development, *Outer Continental Shelf, Bristol Bay(AK), Trajectory simulation.

Effort during this reporting period was to carry out modeling investigations for the Bristol Bay - St. George Basin area and for Norton Sound. The final prediction and verification run of the three-dimensional turbulent energy model was completed for the first study area. Bristol Bay is primarily a tide- and wind-driven system with distinctive nonhomogeneous hydrodynamic behavior. The three-dimensional model is required to characterize its response to these driving forces. The computed current field from predicted tides at the open boundary agrees very well with the observed values in the modeled area. Because of the sensitive interactions between density gradient, vertical shear structure and the vertical momentum exchange processes, it is very difficult to separate the wind and tide effects on the circulation. As a consequence, accuracy in tidal current prediction is a prerequisite in predicting surface drift and the pathways of pollutant discharges. For oil-spill trajectory simulation, extensive computation and graphic programs are under development. In order to provide wind input for the simulation, weather statistics from the Norton Sound area are being analyzed. A suitable method will be selected for generating random wind fields according to the local weather statistics. Trade-offs between several possible methods are being studied. (Sinha-OEIS)
W80-05350

**COMPARISON BETWEEN GEOSTROPHIC WINDS DERIVED FROM THE STANDARD PRESSURE MEASUREMENT NETWORK AND THE AIDJEX NETWORK,**
Washington Univ., Seattle. Polar Science Center.
E. Leavitt.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 46-56, October 1979. 6 Fig, 3 Tab, 6 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Winds, *Ocean currents, *Path of pollutants, Oil spills, Water pollution effects, Resource development, Baseline studies, Environmental effects, Alaska, *Outer Continental shelf, Oil trajectories, Wind direction, Wind speed, Geostrophic wind, Oil-in-ice, Petroleum development.

Studies of ocean current or ice trajectories require specification of the surface air stress. The normal method is to relate the air stress to the geostrophic wind speed calculated from the gradient of the observed surface pressure field. The accuracy of the National Center for Atmospheric Research (NCAR) data set is examined by comparing it to the AIDJEX geostrophic winds and to measurements of surface winds at Point Barrow (BRW), Barter Island (BTI) and the AIDJEX manned camps. The differences reported here should not seriously affect the conclusions about possible mean oil-in-ice trajectories. There are other variables that were not modelled such as ocean currents, that would have a greater influence on the results. The results do indicate a potential problem for studies of ice dynamics because it is the periods at high wind speeds that will be underestimated most severely by an NCAR type data set. Also, although the direction agrees in the mean, there are large random errors in the wind direction that may be important on shorter time scales. (Sinha-OEIS)
W80-05352

**NORTON SOUND/CHUKCHI SEA OCEANOGRAPHIC PROCESSES (N-COP),**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
R. D. Muench, J. D. Schumacher, and R. B. Tripp.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 288-309, October 1979. 1 Fig, 2 Tab, 1 Ref, Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf environmental Assessment Program, Boulder, Colorado.

Descriptors: *Ocean circulation, *Tidal effects, *Sediment transport, *Path of pollutants, Oil pollution, Baseline studies, Resources development, Environmental effects, Water pollution effects, Alaska, *Outer Continental Shelf, Nearshore circulation, Bering Sea/Chukchi Sea, Petroleum development.

Continuing analysis of field data obtained during prior years is enhancing understanding of flow in

the northern Bering Sea, particularly with regard to subtidal fluctuations. Five current meter moorings deployed during summer 1978 yielded data which will help clarify both the regional tides and some aspects of subtidal circulation in the region between Norton Sound and St. Lawrence Island. These data are being provided as necessary input to the tidal modelling effort. Further analysis of the existing field data will address regional tidal behavior and propagation/forcing of subtidal flow events through the system. This study will provide estimates of the trajectories likely to be followed by spilled oil and will furnish an indication of dispersion rates for such oil. Oil introduced into the environment via long-term or chronic leakage is more likely to be dispersed throughout the water column and, possibly, scavened by suspended particulate matter. The problem then becomes one of understanding net transport of suspended matter, a process related to the advective and diffusive fields within the water column. An understanding of these processes requires, in turn, analysis of the velocity field and its driving mechanisms. (Sinha-OEIS)
W80-05355

**OIL POOLING UNDER SEA ICE,**
Cold Regions Research and Engineering Lab., Hanover, NH.
A. Kovacs.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 310-353, October 1979. 3 Fig, 3 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Sea ice, *Ice cover, *Oil spills, *Path of pollutants, Water pollution sources, Environmental effects, Resources development, Arctic, Alaska, Baseline studies, *Outer Continental Shelf, Oil pooling, Petroleum development.

Cross-sectional information on the thickness and bottom relief of sea ice is provided. The subsurface topographic data provide information for determining the direction that oil discharged under fast ice will flow and the quantity of oil which can be expected to pool up within the under-ice relief. The data which have been analyzed to date indicate, as expected, that the cause of the mesoscale relief (5 to 50 cm) found under the fast ice in late winter is due to snow cover variation. In short, where the snow depth is greatest the underlying ice sheet is thinnest due to the insulating effect of the snow, which reduces heat transfer to the atmosphere and therefore ice growth. Studies have shown that where there is a preferred current direction under sea ice the crystal structure of the ice becomes highly ordered. This ordered structure is a complex anisotropic dielectric which was found to be an effective polarizer of transverse electromagnetic waves. Because current effects establish the preferred crystal alignment, the radar signal phenomenon makes it possible to determine the direction of the preferred current under sea ice remotely. Sea ice profiling data from the Tigvariak Island runway site have been partially analyzed and from this information a contour map of a 150-m long section of the profiled runway was made. The profile information shows the strong effect of snow cover variation on under-ice relief and therefore oil pooling potential. (Sinha-OEIS)
W80-05356

**THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE,**
Flow Research Co., Kent, WA.
M. D. Coon, and R. S. Pritchard.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 354-360, October 1979. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Sea ice, *Path of pollutants, *Ice cover, *Water pollution effects, *Oil spills, Baseline studies, Resources development, Environmental effects, Alaska, *Outer Continental Shelf, Prudhoe Bay, Petroleum development.

The objective of this work is to determine the locations to which oil spilled in or under the ice cover near Prudhoe Bay, Alaska, would be transported, and to determine the behavior of the oil as the ice cover moves and deforms. To determine the most likely and extreme sea ice motions, the barometric pressure fields, as determined by the U.S. Weather Service for twenty-five years, were used to determine the winds and, through a sea ice dynamics model, the subsequent sea ice motion. The breakout of the sea ice from the Beaufort to the Chukchi Seas was studied using a rigid plastic model for the behavior of the sea ice to determine the meteorological conditions under which breakout may occur. Studies of the possible fate of oil spilled in the Prudhoe Bay area can provide for a move environmentally safe exploration and development of possible off-shore oil. (Sinha-OEIS)
W80-05357

**BEAUFORT AND CHUKCHI SEA ICE MOTION. PART 1: PACK ICE TRAJECTORIES,**
Flow Research Co., Kent, WA.
D. R. Thomas, and R. S. Pritchard.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 361-469, October 1979. 28 Fig, 1 Tab, 34 Ref, 4 Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Ice cover, *Path of pollutants, *Oil spills, *Currents(Water), *Wind, Water pollution, Arctic, Resources development, Exploration, Baseline studies, Environmental effects, Weather, *Outer Continental Shelf, *Ice trajectories, Beaufort Sea, Chukchi Sea, Petroleum development.

The petroleum industry's anticipated exploration for oil deposits off the north coast of Alaska will involve many new environmental considerations. In addition to the hazards due to the ice, the generally hostile environment will tend to magnify the chances of an oil spill due to other accidents. Once an oil spill occurs, for whatever reason, the ice cover will play a major role in the behavior of the oil. There are many facets to this role: dispersion of the oil under and around the ice, incorporation of the oil into the ice and the eventual release of that oil, the transport of oil trapped in the ice and prevention or enhancement of cleanup. The purpose of this work is to define the range of motions that might be expected for oil spilled on ice during the lifetime of Prudhoe Bay oil fields. It is generally accepted that the primary driving forces of the ice cover are the winds and currents. It is also expected that the ice conditions (i.e., the 'strength' of the ice cover) can have a dominant influence on how the ice behaves in response to these driving forces. Tracking of an actual oil spill requires wind and current observations and prediction at a particular time as well as day to day use of an ice dynamics model to predict motion due to these winds and currents, not a statistical history. The results are presented in graphical form with monthly mean free drift ice motion fields and plots showing temporal and spatial variability. (Sinha-OEIS)
W80-05358

**BEAUFORT AND CHUKCHI SEA ICE MOTION. PART 2: ONSET OF LARGE SCALE CHUKCHI SEA ICE BREAKOUT,**
Flow Research Co., Kent, WA.
R. W. Reimer, R. S. Pritchard, and M. D. Coon.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 470-494, October 1979. 9 Fig, 7 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Ice cover, *Path of pollutants, *Sea ice, *Model studies, Flow, Oil spills, Environmental effects, Resources development, Water pollution, Baseline studies, Alaska, *Outer Continental Shelf, *Ice flow, Bering Strait, Petroleum development.

The period of time during which sea ice is present in the Bering Strait region extends, in general, from mid-November to late June. During this time the ice pack undergoes numerous deformation cycles which at times are extensive enough to cause large scale flow of pack ice south through the Strait. Evidence taken from satellite images of the area indicates that this phenomenon is likely to occur at least once every winter. In order to understand when and why this occurs, it is necessary to learn which material properties of the ice pack control such breakout, as well as to understand the physical environment which influences the ice pack. Sea ice responds to the influence of the atmosphere and ocean, as well as to the surrounding ice pack. If the material response of the ice is assumed to be rigid-perfectly plastic then it becomes possible to obtain some analytic solutions to the response of sea ice under various loads. This is the approach used to model ice breakout through the Bering Strait. Three models of ice flow through the Bering Strait are presented. They model failure by boundary tractions, body forces, or combinations thereof. All three models are able to predict the winds required to cause breakout. (Sinha-OEIS)
W80-05359

**ICE BREAKOUT IN THE BERING STRAIT,**
Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.
R. W. Reimer.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 495-564, October 1979. 8 Fig, 9 Ref, 2 Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Sea ice, *Path of pollutants, *Wind, *Flow, Oil spills, Model studies, Baseline studies, Environmental effects, Resources development, Alaska, *Outer Continental Shelf, *Bering Strait, *Ice flow, Petroleum development.

A rigid-plastic sea ice model developed by the AIDJEX modeling group is used to determine when large-scale ice flow may occur through the Bering Strait. Prediction of failure of an ice arch across the Strait is made in terms of a boundary traction which is related to the strength of winds blowing across the ice pack. The method of solution is to parameterize a wedge-shaped region in the Bering Strait and to model the ice pack in this region as a rigid-plastic material. The choice of a region is based on a visual study of satellite photographs of actual breakout occurrences. A boundary value problem is defined in terms of approximate stress and velocity boundary conditions. Using Prager's theorems on limit analysis, it is shown that an upper and lower bound on a failure load can be calculated if the stresses are assumed constant within subregions of the modeled region. By picking a stress state associated with a kinematically admissible velocity field, a unique failure load is calculated. It is found that for the Bering Strait the failure load is independent of the depth of the modeled region. A simple calculation shows that a wind creating a stress of 0.5 Pa requires a fetch of 200 km to cause breakout. The usefulness of the solution depends primarily on the accuracy of the stress boundary conditions which define the problem. (Sinha-OEIS)
W80-05360

**ARCTIC OIL SPILL SCENARIOS - OUTLINE,**
Flow Research Co., Kent, WA.
M. D. Coon.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 565-569, October 1979. 2 Fig. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Sea ice, *Path of pollutants, *Ocean circulation, Movement, Oil spills, Arctic, Water pollution, Environmental effects, Baseline studies, Resources development, Alaska, *Outer Continental Shelf, *Oil entrapment, Prudhoe Bay, Petroleum development.

Scenarios for twelve conditions will be considered. The conditions will include three separate ice configurations, two different times of year, and two different release volumes. The purpose of this scenario set is to determine the possible fate of oil released into the sea ice in the Prudhe Bay region. The behavior of oil released in the Arctic environment is quite different from the behavior in more temperate climates. The sea ice can act as a natural containment device reducing the areal coverage of a given volume of oil. However, when oil has been entrapped in sea ice, it can remain entrapped for many months before being released to ocean/atmospheric environment or clean up. During the period that the oil is in the ice, it can be transported long distances by the motion of the ice pack. The studies required to understand the spreading of oil beneath sea ice and its subsequent entrapment and transportation by the sea ice are now being conducted. Therefore, at this point only a broad outline of the scenarios can be presented. (Sinha-OEIS)
W80-05361

**THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE - TASK 1,**
ARCTEC, Inc., Columbia, MD.
L. A. Schultz, and J. C. Cox.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 570-588, October 1979. 8 Fig, 9 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-78-B01-62.

Descriptors: *Oil spills, *Sea ice, *Movement, Ice cover, Path of pollutants, Baseline studies, Resources development, Water pollution effects, Environmental effects, Alaska, Water pollution, *Outer Continental Shelf, Beaufort Sea, Chukchi Sea, Oil transport.

This study addresses four basic spill related phenomena, slick thickness, the motion of oil beneath smooth ice and ice having small roughness features, the motion of oil beneath ice having large roughness features, and the vertical migration of oil in ice. The purpose of this study is to examine how oil from a spill will interact with the sea ice of the Beaufort and Chukchi Seas. The scope of the problem encompasses both the horizontal movement and the vertical migration of oil. The horizontal transport of oil has been studied in an ice covered laboratory flume. Conclusions on the vertical migration of oil in ice are based on observations made during both field and laboratory experiments. The results of these oil-ice interaction studies will be incorporated into the AIDJEX model of ice dynamics to provide a means for predicting the ultimate fate of oil spilled in ice infested waters. (Sinha-OEIS)
W80-05362

## 5B. Sources Of Pollution

**NITROGEN FERTILIZER MANAGEMENT OF VIGOROUS LEMONS AND NITRATE-POLLUTION POTENTIAL OF GROUNDWATER,**
California Univ., Riverside. Dept. of Botany and Plant Sciences.
T. W. Embleton, C. O. Pallares, W. W. Jones, L. L. Summers, and M. Matsumura.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-183510, Price codes: A03 in paper copy, A01 in microfiche. California Water Resources Center, University of California, Davis Technical Completion Report, Contribution 182, December 1979. 29 p, 11 Fig, 15 Tab. (California Water Resources Project UCAL-WRC-W-500). OWRT-A-057-CAL(2).

Descriptors: Citrus fruits, *Lemons, Oranges, Fruit crops, Crop production, *Nitrogen, Nitrification, *Nitrogen fixing bacteria, *Nitrates, *Ureas, *Fertilizers, *Foliar application, Groundwater, *Water pollution, Leaching.

The mission of this project was to develop practical citrus nitrogen fertilizer management programs that would reduce nitrate-pollution potential without having adverse effects on fruit yield, size, and quality. Studies were conducted on 'Washington' navel orange and 'Limoneira 8a Lisbon' lemon. Supplying the trees' nitrogen needs by means of urea foliar sprays resulted in a lower nitrate-pollution potential than by applying nitrogen fertilizer to the soil. An increase in the annual soil-applied nitrogen rate was associated with an increase in the nitrate-pollution potential. November applied nitrogen treatments to lemons were associated with a higher nitrate-pollution potential than the same annual nitrogen rate applied in March, or in a split application. Experimental treatments to lemons did not influence drainage volumes (the amount of water passing below the rootzone annually). Nitrogen leach was not significantly correlated with drainage volume. Very highly significant linear correlations were observed for the following: Nitrogen leached vs. nitrogen rate, nitrogen leached vs. nitrate-nitrogen concentration in drainage water, and nitrate-nitrogen concentrations in drainage water vs. nitrogen rate. An increase in soil-applied nitrogen rate to lemons increased the amount of nitrogen removed in the harvested crop. For a given annual nitrogen rate, foliar-applied treatments were associated with a substantially greater amount of nitrogen removed in the harvested crop than were the soil-applied treatments. (Snyder-California)
W80-05103

**INFLUENCE OF REGOLITH PROPERTIES ON MIGRATION OF SEPTIC TANK EFFLUENT,**
University of South Florida, Tampa. Dept. of Geology.
R. A. Rea, and S. B. Upchurch.
Ground Water, Vol 18, No 2, p 118-125, March-April 1980. 6 Fig, 1 Tab, 28 Ref.

Descriptors: *Septic tanks, *Groundwater, *Path of pollutants, *Groundwater movement, *Regolith, Nutrients, Pollutants, Nitrates, Chlorides, Phosphorus, Hydrogen ion concentration, Soils, Soil water, Adsorption, On-site investigations, Sampling, Chemical analysis, Mathematical models, Hydrogeology, Hydrology, Soil adsorption.

An investigation of waste-migration patterns from a septic system indicated that complex patterns result from minor variations in regolith adsorptive capacity and texture, local hydrology, and possibly soil microbiology. The existence of multichemical, bifurcating plumes suggested that monitor wells arranged up and downgradient and capable of multilevel sampling are essential to adequately delineate contaminant migration in groundwater. The data also indicated that sampling for a single constituent could yield misleading information about the nature and distribution of other groundwater contaminants. The ability for chemical removal by the regolith is in direct response to minor variations in silt- and clay-sized particle content and corresponds to Langmuir adsorption isotherms. Silt- and clay-sized particles are dominantly organic in origin. Minor iron and aluminum hydroxyoxides and clays are present. Substrate samples, when collected at regular intervals and analyzed for adsorbed constituents and textural variability, provided an integrated picture of the distribution of waste chemicals through time. Such samples also provided insight into the mechanics of plume configuration and flow characteristics within the regolith. The study showed that regolith adsorption data are essential to the determination of life expectancy of the regolith as a contaminant treatment system. (Sims-ISWS)
W80-05124

**REQUIREMENTS OF STATE REGULATORY AGENCIES FOR MONITORING GROUNDWATER QUALITY AT WASTE DISPOSAL SITES,**
Minnesota Pollution Control Agency, Minneapolis.
For primary bibliographic entry see Field 5A.
W80-05129

**REACTOR-RELEASED RADIONUCLIDES AND FINE-GRAINED SEDIMENT TRANSPORT AND ACCUMULATION PATTERNS IN BARNEGAT BAY, NEW JERSEY AND ADJACENT SHELF WATERS,**
Lamont-Doherty Geological Observatory, Palisades, NY.
C. R. Olsen, P. E. Biscaye, H. J. Simpson, R. M. Trier, and N. Kostyk.
Estuarine and Coastal Marine Science, Vol 10, No 2, p 119-142, February 1980. 5 Fig, 7 Tab, 27 Ref. ERDA EY-76-S-02-2185, EY-76-S-02-2529.

Descriptors: *Radioisotopes, *Nuclear powerplants, *Fallout, *Sediments, *New Jersey, On-site investigations, Sampling, Coasts, Bays, Continental shelf, Water pollution, Water pollution sources, Sediment transport, Spatial distribution, Temporal distribution, Cobalt radioisotopes, Cesium, Pollutants, Path of pollutants.

Anthropogenic radionuclides have been introduced into the Barnegat Bay environment via global fallout from nuclear weapons testing and by low-level discharges from the Oyster Creek Nuclear Generating Station. A significant portion of these radionuclides have been adsorbed to fine-grained particles and consequently provide excellent tracers for fine-sediment transport and accumulation patterns in the Bay and adjacent shelf environment. Fine-grained particles tagged with reactor nuclides are presently accumulating along the landward shore of Barnegat Bay at rates between 1 and 7 cm/year. There is some indication that reactor-tagged sediments are also being transported into the mouths of small tributaries which discharge into the Bay. Reactor-tagged particles that escape from the Bay, through Barnegat Inlet, onto the shelf, are accumulating during the summer with fine-grained material from other sources, in depressions along the shelf bottom. These near-shore mud deposits are apparently resuspended and dispersed by major storms probably on a seasonal basis. By comparing radionuclide ratios in the reactor releases with the ratios observed in the fine-grained sediments in the vicinity of the reactor, it appears that (1) 35% to 50% of the total 137Cs activity in the top 30 cm of the sediments in Oyster Creek is attributable to reactor releases; (2) if transuranic releases have occurred from the Oyster Creek Reactor, the increments of 239, 240Pu and 238Pu are not distinguishable from the fallout plutonium burden in the sediments; and (3) radiocobalt is removed from the liquid effluent and stored in the sediments at least 20 X more effectively than radiocesium. (Sims-ISWS)
W80-05130

**COMPARATIVE NUTRIENT DYNAMICS OF A MARSH-MUDFLAT ECOSYSTEM,**
Connecticut Univ., Groton. Marine Sciences Inst.
B. L. Welsh.
Estuarine and Coastal Marine Sciences, Vol 10, No 2, p 143-164, February 1980. 9 Fig, 6 Tab, 39 Ref. Army DACW 33-75-C-0059.

Descriptors: *Nutrients, *Water chemistry, *Rivers, *Estuaries, *New England, Tidal waters, Coasts, Marshes, Salt marshes, Sampling, Surveys, Nitrates, Nitrites, Ammonia, Phosphates, Tides, Tidal effects, Circulation, Water circulation, Pollutants, Water pollution, Path of pollutants.

An open marsh front, its adjacent mudflat, and a dredged channel in the Branford River estuary on the north shore of Long Island Sound were compared to determine their individual contributions to nutrient dynamics in the overall system, to identify mechanisms involved, and to evaluate whether open-system dynamics agreed with those reported for closed systems. Basic patterns of nutrient flux differed between areas, between tidal phases, and between summer and fall. The relative magnitudes of nutrient activity generally were: ammonia greater than phosphate greater than nitrate greater than

nitrite, regardless of area, tide, or season. The channel consistently exported materials. The marsh was heterotrophic with respect to tidal water, removing oxygen and releasing large quantities of phosphate and ammonia, especially during summer months. The mudflat was autotrophic during the day, recharging passing waters with oxygen and effectively removing the pulses of nutrients released from the marsh. Both marsh and mudflat strongly conserved nitrate. Nutrient removal over the mudflat was due to uptake by geochemical or biological activity of the sediments and to the macrophyte, Ulva latuca. During its growing season, Ulva was suspended by tides which increased its area of contact with passing water 6-20 times that of the underlying mudflat surface and added a third dimension to the epibenthic component. The flood tide physically entrained mudflat surface sediments and their associated high-nutrient pore waters, which increased nutrient concentrations in the water column. Through removal on the ebb and recharge on the flood, a steep gradient was maintained between marsh and channel, especially during summer when Long Island Sound water was most nutrient depleted and represented a potential leaching stress. (Sims-ISWS)
W80-05131

**WATER QUALITY TRAP EFFICIENCY OF STORM WATER MANAGEMENT BASINS,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W80-05139

**FIELD AND MODEL RESULTS FOR MULTIPORT DIFFUSER PLUME,**
Tennessee Valley Authority, Norris.
C. W. Almquist, C. D. Ungate, and W. R. Waldrop.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 27-37, 1978. 6 Fig, 6 Ref.

Descriptors: *Model studies, *Hydraulic structures, *Heated water, *Reservoirs, Mathematical models, On-site investigations, Diffusion, Water temperature, Spatial distribution, Analysis, Analytical techniques, Currents(Water), Velocity, Thermal plume, Multiport diffuser.

The three-unit Browns Ferry Nuclear Plant of the Tennessee Valley Authority (TVA) has a net generating capacity of 3456 MW. Condenser cooling water from this plant is discharged into Wheeler Reservoir through a submerged multiport diffuser at temperature rises of up to 25F. Alabama water quality standards limit the plant-induced mixed temperature rise in the reservoir to 5F. Because the plant may operate either with or without cooling towers, the ability to predict accurately plant-induced temperature rises has a direct bearing on plant efficiency. In this paper, an analytical model for predicting the plant-induced temperature rise was presented, and results from a field study under controlled conditions were discussed and compared with model predictions. Field data collection programs should be designed so as to best take advantage of available techniques for data analysis. In this respect, large area, multidimensional contour maps may not be as useful as measurements at fixed points or over a smaller area of the temperature field. This should be taken into consideration in the design of field tests. Analytical and empirical models of diffuser performance offer a relatively simple means of adequately predicting many aspects of diffuser performance. The reasonable agreement of the very simple model with observed temperatures has provided the impetus for the development of a more general, comprehensive model of diffuser performance. (See also W80-05159) (Humphreys-ISWS)
W80-05160

**AN ANALYSIS OF TOTAL PHOSPHORUS TRANSPORT IN RIVER SYSTEMS,**
West Virginia Univ., Morgantown.
F. H. Verhoff, D. A. Melfi, and S. M. Yaksich.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 147-155, 1978. 6 Fig, 5 Ref.

Descriptors: *River systems, *Water quality, *Model studies, *Ohio, Phosphorus, Analytical techniques, Analysis, Mathematical models, On-site data collections, Hydrographs, Distance, Phosphorus transport, Mass balance, Chemograph.

Two views of phosphorus transport during storms can be summarized as follows. The continuous flow theory envisions the total phosphorus as being washed from the land, through the river system, and into the receiving water body during one storm event. The discontinuous theory would propose that the phosphorus is moved from the land and through the stream by a series of flood waves. The first wave would carry the material from the land into the river bed. The second wave would pick up the total phosphorus, carry it some distance, and redeposit it in the river again. This process would continue until the total phosphorus reaches the receiving water body. The first section of this paper involved mathematical modeling which demonstrated that total phosphorus was transported by a resuspension-deposition process. The second section contains a methodology for calculating the net distance of travel for total phosphorus during a storm event. The last section uses the fact of increasing concentration with increasing flow to develop our total phosphorus flux estimating technique. The modeling indicates that total phosphorus is transported by a resuspension-deposition process. The distance of travel was calculated from information at a point in a river. During large storms, most of the total phosphorus passing mainstem stations reaches Lake Erie. The total phosphorus flux entering the lake was estimated at USGS gaging station by a flow interval method. (See also W80-05159) (Humphreys-ISWS)
W80-05171

**A DYNAMIC ESTUARY MODEL OF CHARLESTON HARBOR,**
CH2M/Hill, Reston, VA.
For primary bibliographic entry see Field 2L.
W80-05178

**VERIFICATION OF A YORK RIVER ECOSYSTEM MODEL,**
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5C.
W80-05180

**SIMULATION OF ALGAL GROWTH IN THE CHOWAN RIVER,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W80-05181

**MATHEMATICAL MODELING OF SEDIMENT AND CONTAMINANT TRANSPORT IN THE JAMES RIVER ESTUARY,**
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2J.
W80-05185

**FIELD VERIFICATION OF A HYDROTHERMAL MODEL,**
Worcester Polytechnic Inst., Holden, MA. Alden Research Labs.
G. E. Hecker, and J. J. Markowsky.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 326-334, 1978. 3 Fig, 3 Ref.

Descriptors: *Cooling water, *Thermal pollution, *Lake Michigan, *Model studies, Hydraulic models, On-site investigations, Calibrations, Heated water, Discharge(Water), Temperature, Water temperature, Powerplants, Water circulation, Currents(Water), Lakes.

Hydraulic models are frequently used to predict temperature rise patterns produced by heated discharges from steam-electric stations. Although considerable progress has been made in analytic techniques in recent years, no reliable analysis was available to predict the dilution of buoyant effluent discharged at relatively high velocity from two submerged and adjacent slots in shallow water. Complex flow interactions and boundary effects prompted the use of a physical model to develop a discharge concept for the Donald C. Cook Nuclear Plant on Lake Michigan such that the thermal plume would meet applicable temperature rise criteria. Subsequent to the start-up of Unit 1 of the two unit plant, an extensive field monitoring program was supported to check compliance with thermal regulations. A few of the numerous thermal plumes were gathered under ambient lake conditions similar to those used in the physical model, and a model-field comparison was, therefore, possible. (See also W80-05159) (Sims-ISWS)
W80-05187

**A MATHEMATICAL MODEL FOR WATER QUALITY ANALYSIS,**
Virginia Inst. of Marine Science, Gloucester Point.
H. S. Chen.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 350-357, 1978. 4 Fig, 6 Ref.

Descriptors: *Water quality, *Hydrodynamics, *Biochemistry, *Model studies, Mathematical models, Rivers, Bays, Estuaries, Water circulation, Pollutants, Dispersion, Path of pollutants, Equations, Mathematics, Calibrations, James River Estuary(VA).

When wastes are introduced to a natural water body, they are, in general, subject to the coupled influence of hydrodynamic transport processes and biochemical reaction processes. The former, mainly depending on flow circulation, includes advection, mixing, and dispersion of the constituents of the wastes, while the latter, which leads to production or decay or transformation of the constituents through biochemical interaction, depends on both the biochemical characteristics of the constituents of the wastes and the hydrodynamic behavior of the water body. The purpose of this work was to develop a real-time, two-dimensional, depth-integrated mathematical model, which depicts a hydrodynamic and biochemical water quality system to predict flow circulation, water elevation, and water quality response in a natural water body such as river, estuary, or sea. (See also W80-05159) (Sims-ISWS)
W80-05190

**WATER QUALITY MODELING USING HYDROCOMP SIMULATION PROGRAMMING (HSP),**
Hydrocomp, Inc., Palo Alto, CA.
R. G. Bourne, G. N. Day, and T. N. Debo.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 358-362, 1978. 1 Fig.

Descriptors: *Water quality, *Rivers, *Model studies, Mathematical models, Calibrations, Flow, Streamflow, Chemicals, Pollutants, Oxygen, Dissolved oxygen, Bacteria, Nutrients, Water temperature, Solar radiation, Winds, Humidity, Hydrology.

Hydrocomp Simulation Programming (HSP) is a mathematical model capable of continuously simulating the hydrologic and water quality responses of a watershed. Continuous simulation essentially refers to use of long-term precipitation records to generate long-term flows. From the flows, the dynamic processes controlling water quality can be simulated for extended periods. The basic philosophy undergirding the simulation of water quality (using HSP) is that hydrology is a major mechanism controlling critical situations, assimilative capacity, and many other water quality processes.

From the long-term simulation of water quality, probabilities of a particular event can be determined. For example, the percent of time DO falls below 5 mg/l can be estimated. The model incorporates many of the basic physical, chemical, and biological processes controlling water quality and can include factors which impact it (e.g., point and nonpoint loads). However, only as much confidence can be placed in simulation results as can be placed in the data base used for calibration and verification. (See also W80-05159) (Sims-ISWS)
W80-05191

**CALIBRATION OF URBAN NONPOINT POLLUTION LOADING MODELS,**
Northern Virginia Planning District Commission, Falls Church.
J. P. Hartigan, A. M. Lumb, J. T. Smullen, T. J. Grizzard, and P. A. Alcivar.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 363-372, 1978. 3 Tab, 14 Ref, 1 Append.

Descriptors: *Water pollution sources, *Urban runoff, *Model studies, Mathematical models, Cities, Pollutants, Water pollution, Path of pollutants, Monitoring, Chemical oxygen demand, Lead, Zinc, Phosphorus, Nitrogen, Land use, Runoff, Hydrology, Calibrations, Nonpoint water pollution sources.

Recent studies have begun to quantify the magnitude of pollution loadings from nonpoint sources and to question water quality management strategies founded solely on point source abatement. In order to evaluate trade-offs between point and nonpoint pollution control strategies for an urban area, existing and projected nonpoint pollution loadings must be characterized. Such characterizations are generally based on applications of mathematical models that utilize relationships between land use characteristics and the timing and magnitude of runoff pollution releases. Useful relationships between point source pollution loadings and land use (i.e., population equivalents) are readily available in standard reference texts. Appropriate relationships between nonpoint pollution loadings and urban and rural-agricultural land uses are not so readily available. This paper described the use of continuous simulation model calibration techniques to derive 'urban land use-nonpoint pollution' correlations for subsequent model applications in mixed land use watersheds. Major elements in a runoff pollution field study that produced the required model calibration data were summarized. Hydrology and water quality calibration results were presented. Simulated unit area loading rates from the pervious and impervious fractions of urban land uses were compared. (See also W80-05159) (Sims-ISWS)
W80-05192

**MODEL VERIFICATION USING THE PLUG-FLOW TECHNIQUE,**
Battelle Pacific Northwest Labs., Richland, WA. Water and Land Resource Dept.
S. M. Brown, and A. Brandstetter.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 373-380, 1978. 7 Fig, 2 Ref, 1 Append.

Descriptors: *Rivers, *Path of pollutants, *Flow, *Model studies, Mathematical models, Calibrations, Water quality, Nutrients, Algae, Water temperature, Chemicals, Dissolved oxygen, Hydrology, Plug-flow technique.

A unique approach to steady-state river water quality modeling has been found to be especially useful in the model calibration/verification process. This approach, known as the plug-flow technique, involves the routing of a hypothetical plug of water through successive river reaches according to flow travel time. This routing procedure makes it possible to incorporate the effects of certain time-varying water quality factors, such as algal photosynthesis/respiration, water temperature, waste loads, and tributary inflows, into the simulation structure of a steady-state model. Model calibration and verification using this approach requires water quality data which are functionally related to river travel time. In support of a 208 Areawide Waste Management Planning Study, the plug-flow technique was used to calibrate and verify a steady-state model which simulates the important water quality phenomena affecting dissolved oxygen changes in rivers, including the effects of waste loads, nutrient cycling, algal activity, and water temperature. Approximately 50 miles of the Chemung River system in New York, including the lower Cohocton River and seven municipal and industrial waste sources, were modeled. In addition to model verification, the plug-flow approach proved to be extremely valuable in waste-load allocation studies where both minimum and average daily dissolved oxygen concentrations had to be simulated for comparison with the New York State water quality standards. (See also W80-05159) (Sims-ISWS)
W80-05193

**PLANNING IMPLICATIONS OF WASTE-LOAD ASSIMILATIVE CAPACITY OF COLEMAN CREEK AND FLAT CREEK, MECKLENBURG COUNTY, VIRGINIA,**
Virginia State Water Control Board, Richmond. Piedmont Regional Office.
C. T. Bathala, K. C. Das, and W. D. Jones.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 472-482, 1978. 4 Fig, 2 Tab, 6 Ref.

Descriptors: *Water quality, *Water pollution, *Path of pollutants, *Model studies, *Virginia, Mathematical models, Planning, Water pollution sources, Dispersion, On-site data collections, Calibrations, Pollutants, Biochemical oxygen demand, Dissolved oxygen, Nitrogen, Effluents, Water temperature, Streams, Streamflow.

This paper summarized the results of waste-load assimilation analyses of Coleman Creek at Boydton and Flat Creek near South Hill, Virginia, and the possible impact on these communities. Coleman Creek and Flat Creek are two small, free-flowing streams in the South Piedmont Region of Virginia. The assimilative capacity of each stream was analyzed by using modified Streeter-Phelps methodology, a water quality model for self-purification of small streams. Each model was calibrated and verified using two different sets of field data. Based on the results of these studies, it became apparent that very stringent effluent limits, overtaxing the financial capabilities of these communities, would be needed to maintain the existing stream DO standards. (See also W80-05159) (Sims-ISWS)
W80-05199

**EFFECTS OF EQUATION AVERAGING ON MODEL VERIFICATION,**
South Carolina Univ., Columbia. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W80-05200

**A GRAPHICAL COMPUTATION SYSTEM FOR THREE-DIMENSIONAL LAKE CIRCULATION AND CONTAMINANT DISPERSION,**
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 7C.
W80-05205

**A STOCHASTIC-DYNAMIC APPROACH TO THE FOUNDATIONS OF SOLUTE TRANSPORT IN POROUS MEDIA,**
Mississippi Univ., University. Dept. of Civil Engineering.
V. K. Gupta, R. N. Bhattacharya, and G. Sposito.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 621-629, 1978. 26 Ref.

Descriptors: *Porous media, *Solutes, *Movement, *Theoretical analysis, Mathematical models, Water quality, Analytical techniques, Analysis, Stochastic processes, Statistical methods, Flow, Mathematical studies, Solute transport.

The authors developed a stochastic theory explicitly based on dynamic considerations. Since the dynamics were specified at the molecular level, the theory did not require that a hydrodynamic description be applicable at the 'pore level.' This fact also enabled the authors to avoid making restrictive and artificial assumptions on the geometry of a porous medium. (See also W80-05159) (Humphreys-ISWS)
W80-05216

**STOCHASTIC WATER QUALITY MODEL,**
Auburn Univ., AL. Dept. of Civil Engineering.
L. C. Bell.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 638-644, 1978. 2 Fig, 1 Tab, 5 Ref.

Descriptors: *Water quality, *Mathematical models, *Stochastic processes, *Oxygen sag, Statistical methods, Model studies, Dissolved oxygen, Statistical models, Analytical techniques, Monte Carlo method, Streamflow, On-site investigations, Model verification.

The stochastic water quality model DOSIM was developed to provide water quality planners with a more realistic oxygen sag analysis of small streams without the added expense of an expanded data base. The familiar Streeter-Phelps oxygen sag equation with a suitable modification for nitrification was selected as a basic mathematical equation. Monte Carlo methods were employed to generate downstream dissolved oxygen histograms from input data in the form of histograms, probability density functions, or constant values. In this study historical data supplied by the state regulatory agency was inadequate for validation purposes because of the large time span involved and the resulting wide variation in flow and runoff parameters. A carefully controlled monitoring of a local stream during the late summer months did, however, produce data compatible with model assumptions, and validity was ascertained using the nonparametric Kolmogorov-Smirnov test. (See also W80-05159) (Humphreys-ISWS)
W80-05218

**SEDIMENT AND PCB TRANSPORT MODEL OF THE HUDSON RIVER,**
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
For primary bibliographic entry see Field 2J.
W80-05219

**VERIFICATION OF TRANSIENT MIXED-FLOW MODEL,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 8B.
W80-05224

**TWO-DIMENSIONAL TIDALLY AVERAGED ESTUARINE MODEL,**
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
For primary bibliographic entry see Field 2L.
W80-05251

**QUANTITATIVELY TRACING BACTERIAL TRANSPORT IN SATURATED SOIL SYSTEMS,**
Oregon State Univ., Corvallis. Dept. of Microbiology.
E. L. McCoy, and C. Hagedorn.
Water, Air, and Soil Pollution, Vol 11, No 4, p

467-479, May 1979. 4 Fig, 2 Tab, 26 Ref. OWRT A-039-ORE(3), 14-34-0001-9039.

Descriptors: *E. coli, *Water pollution sources, *Septic tanks, *Groundwater, Soil environment, Saturated flow, Soil water, Enteric bacteria, Groundwater movement, Perched water, Water table, Water pollution, Coliforms, Hazards, Public health, Transport, Fecal organisms.

Three isolates of Escherichia coli were labeled by their resistance to sodium azide and, separately, to novobiocin, nalidixic acid, and tetracycline. The strains exhibited a high degree of persistence in the soil environment and were recoverable on strain specific media at levels within the 95% confidence interval of the numbers covered on nonselective media. The E. coli strains were subsequently used to evaluate the events which would occur when a septic tank drainfield became submerged in a perched water table and effluent-borne bacteria escaped into the groundwater. Field experiments were conducted by introducing the strains into horizontal lines installed into the A, B, and C horizons of a soil profile, and transport was evaluated by collecting groundwater samples from 5 rows of piezometers (sampling 6 separate depth zones/row) located downslope from the injection lines. The major portion of subsurface transport of the bacterial populations occurred in specific zones in the soil profile and at an apparent maximum velocity of 17.0 cm/min. The maximum bacterial density in the groundwater, observed at each sampling distance downslope, was used to produce a mathematical relationship which described the overall decrease in numbers of organisms with increased distance through the soil. The potential health hazards which could occur by the subsurface transport of fecal organisms in relation to these experiments were discussed. (Visocky-ISWS)
W80-05252

**WATER QUALITY MODELING IN THE UPPER REACHES OF THE CHOWAN RIVER,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
D. N. Contractor, and P. H. King.
Water Resources Bulletin, Vol 16, No 1, p 118-126, February 1980. 10 Fig, 1 Tab, 14 Ref. OWRT B-074-VA(2).

Descriptors: *Water quality, *Rivers, *Algae, *Model studies, Mathematical models, Nutrients, Pollutants, Water pollution, Path of pollutants, Biochemical oxygen demand, Chemical oxygen demand, Dissolved oxygen, Nitrogen, Nitrogen compounds, River flow, Streamflow, Hydrology, *Chowan River(VA-NC).

The Chowan River system consists of three rivers in southeast Virginia that form two confluences before flowing into Albermarle Sound in North Carolina. A computer program was written to simulate flows through the river system to determine flow rates, velocities, and depths. The output of the flow program was input into a second program that calculated the concentrations of BOD5, COD, DO, and four nitrogen parameters (organic, ammonia, nitrite-nitrate, and algal-N). Measured field data were used to calibrate the model. The effect of reducing the concentration of nutrients from overland runoff on algal concentrations at the mouth of the river was studied. The program was also run to simulate the water quality of the watershed in a primitive condition, in which the watershed was assumed to consist only of forests. The results of the computer program indicate that the major changes in the water quality of the river are simulated satisfactorily. The program can be used to assess the impact of any management scheme to improve water quality. (Sims-ISWS)
W80-05253

**MODIFYING AUTOMATED PUMPING SAMPLERS FOR USE IN SMALL MOUNTAIN STREAMS,**
Oregon State Univ., Corvallis. School of Forestry.
For primary bibliographic entry see Field 5A.
W80-05256

**IRRIGATOR INVOLVEMENT IN THE IMPLEMENTATION OF AGRICULTURAL NON-POINT SOURCE POLLUTION CONTROL PROGRAMS,**
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 5G.
W80-05257

**DISSOLVED OXYGEN IN INTRAGRAVEL WATER OF THREE TRIBUTARIES TO REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA,**
Geological Survey, Helena, MT.
P. F. Woods.
Water Resources Bulletin, Vol 16, No 1, p 105-111, February 1980. 4 Fig, 4 Tab, 22 Ref.

Descriptors: *Dissolved oxygen, *Streams, *Gravels, *California, Tributaries, Forestry, Lumbering, Water quality, Oxygen, Sampling, On-site investigations, Fish, Salmon, Fish eggs, *Intragravel water, *Redwood Creek(CA), *Redwood National Park(CA).

As part of a study of Redwood National Park in northwestern California, an investigation was conducted from June to November 1974 on intragravel dissolved oxygen and sediment in three tributaries to Redwood Creek, a major coastal stream that flows through Redwood National Park. Of concern was whether the intragravel environment of streams in logged and unlogged redwood-forested drainage basins was different. The tributary in the unlogged drainage basin had lower percentages of fine streambed sediment than either of the tributaries in logged drainage basins. Concentration and percentage saturation of dissolved oxygen of intragravel water were highest in the stream in the unlogged drainage basin, intermediate in the stream in the patch-cut drainage basin, and lowest in the stream in the clear-cut drainage basin. The differences in intragravel dissolved-oxygen conditions among the three tributaries are attributed chiefly to differences in their interchange of surface and intragravel water. The larger quantities of fine streambed sediment in the two streams in logged basins may have reduced the permeability of the streambeds and hence their capacity to interchange surface and intragravel water. However, differences in the lithology of the three tributary drainage basins examined may contribute to the differences in the percentage of fine sediments observed among the streams, even in the absence of logging. (Sims-ISWS)
W80-05259

**COLIFORMS AND WATER QUALITY: USE OF DATA IN PROJECT DESIGN AND OPERATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
K. W. Thornton, J. F. Nix, and J. D. Bragg.
Water Resources Bulletin, Vol 16, No 1, p 86-92, February 1980. 6 Fig, 4 Tab, 15 Ref.

Descriptors: *Water quality, *Coliforms, *Path of pollutants, *Reservoirs, *Arkansas, Rivers, Projects, Design, Bacteria, E. Coli, Pathogenic bacteria, Water pollution, Surface waters, Flow, Turbidity, Sampling, On-site investigations, *Caddo River(AR), *DeGray Reservoir(AR).

Knowledge of coliform transport and disappearance may provide information for project design and operation that minimizes potential water quality problems such as the violation of body contact recreation standards. Storm events were sampled in the Caddo River above DeGray Reservoir, Arkansas, and then tracked through the reservoir using the increased turbidity associated with the storm flows. Fecal coliforms were sampled both in the river and throughout the water column in the reservoir. In general, increased fecal coliform concentrations were closely associated with the increased turbidity resulting from the storm flows. This association existed for all three types of turbidity plume movement--overflow, interflow, and underflow. As the turbidity plume moved down the reservoir, fecal coliform concentrations decreased due to die-off, settling, and dilution. With several assumptions, it is possible to use this information to assist in locating recreational sites in a reservoir or to anticipate possible body contact standard violations at existing recreation sites. (Sims-ISWS)
W80-05262

**WATER QUALITY PROJECTIONS: PREIMPOUNDMENT CASE STUDY,**
Maryland Univ., College Park, Dept. of Civil Engineering.
R. H. McCuen, D. E. Cook, and R. L. Powell.
Water Resources Bulletin, Vol 16, No 1, p 79-85, February 1980. 9 Tab, 8 Ref.

Descriptors: *Water quality, *Reservoirs, *Model studies, *Maryland, Mathematical models, Data collections, Basic data collections, Surface waters, Runoff, Urban runoff, Precipitation(Atmospheric), Pollutants, Water temperature, Turbidity, Dissolved solids, Dissolved oxygen, Nutrients, Coliforms, Biochemical oxygen demand, Land use, Urbanization.

Recent regulations require impact statements for major water development projects, including reservoirs that will be used for water supply, recreation, and pollution control. A water quantity/quality model was developed and used for making water quality projections of a proposed reservoir in Montgomery County, Maryland. The study area was uncommon in that there was an extensive water quality data base. The results indicated that land use changes will have a significant effect on water quality and that the proposed reservoir will improve the quality of the surface waters downstream from the reservoir. A major effect of land use changes is the increase in the variability of water quality. (Sims-ISWS)
W80-05263

**SURFACE DISTRIBUTIONS OF AEROBIC HETEROTROPHS AND THEIR RELATIONSHIPS TO TEMPERATURE AND NUTRIENTS IN LAKE SUPERIOR DURING 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05272

**ORGANOCHLORINE SUBSTANCES IN LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05274

**SIMULATION OF WATER CIRCULATIONS AND CHLORIDE TRANSPORTS IN LAKE SUPERIOR FOR SUMMER 1973,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05280

**MODERN MARINE SEDIMENTS AS A NATURAL ANALOG TO THE CHEMICALLY STRESSED ENVIRONMENT OF A LANDFILL,**
Geological Survey, Reston, VA. Water Resources Div.
M. J. Baedecker, and W. Back.
Journal of Hydrology, Vol 43, p 393-414, 1979. 9 Fig, 1 Tab, 48 Ref.

Descriptors: *Geochemistry, *Sediments, *Chemical reactions, *Environmental effects, *Landfills, Path of pollutants, Organic compounds, Fermentation, Oxidation-reduction potential, Gases, Leachate, Waste disposal, Isotope fractionation, Aquifers, Groundwater movement, Water quality, Delaware.

Chemical reactions that occur in landfills are analogous with those reactions that occur in marine sediments. Lateral zonation of C, N, S, O, H, Fe, and Mn species in landfills is similar to the vertical zonation of these species in marine sediments and results from the following reaction sequence: (1)

oxidation of C, N, S species in the presence of dissolved free oxygen to HC03(-), N03(-), and S04(=), (2) after consumption of molecular oxygen, then N03(=) is reduced and FE and Mn are solubilized, (3) S04(=) is reduced to sulfide, and (4) organic compounds become the source of oxygen, and CH4 and NH4 (+) are formed as fermentation products. In a landfill in Delaware the oxidation potential increases down-gradient and the redox zones in the reducing plume are characterized by: CH4(-), NH4(+), Fe(++), Mn(++), HC03(-), and N03(-). Lack of S04(=) at that landfill eliminates the sulfide zone. Although it has not been observed at landfills, mineral alteration should result in precipitation of pyrite and/or siderite downgradient. Controls on the pH of leachate are the relative rates of production of HC03(-), NH4(+), and CH4. Production of methane by fermentation of landfills results in carbon-13 isotope fractionation and the accumulation of isotopically heavy Sigma C02 (+10% to +18%)PDB. Isotope measurements may be useful to determine the extent of C02 reduction in landfills and extent of dilution downgradient. The boundaries of reaction zones in stressed aquifers are determined by head distribution and flow velocity. Thus, if the ground-water flow is rapid relative to reaction rates, redox zones will develop downgradient. Where ground-water flow velocities are low the zones will overlap to the extent that they may be indeterminate. (Kosco-USGS)
W80-05293

**DIGITAL-TRANSPORT MODEL STUDY OF DIISOPROPYLMETHYLPHOSPHONATE (DIMP) GROUND-WATER CONTAMINATION AT THE ROCKY MOUNTAIN ARSENAL, COLORADO,**
Geological Survey, Lakewood, CO. Water Resources Div.
J. W. Warner.
Available from: OFSS, Box 25425, Fed Ctr, Denver CO 80225. Price codes: $5.50 in paper copy, $3.50 in microfiche. Geological Survey open-file report 79-676, August 1979. 39 p, 25 Fig, 6 Ref.

Descriptors: *Model studies, *Groundwater, *Water pollution, *Chemical wastes, *Path of pollutants, Waste disposal, Ponds, Groundwater movement, Groundwater barriers, Aquifer characteristics, Mathematical models, Evaluation, Colorado, *Rocky Mountain Arsenal(Colo), *Digital transport model, *Diisopropylmethylphosphonate.

Diisopropylmethylphosphonate (DIMP) is an organic compound produced as a by-product of the manufacture and detoxification of GB nerve gas. Ground-water contamination by DIMP from the disposal of wastes into unlined surface ponds at the Rocky Mountain Arsenal occurred from 1952 to 1956. A digital-transport model was used to determine the effects on ground-water movement and on DIMP concentrations in the ground water of a bentonite barrier in the aquifer near the northern boundary of the arsenal. The transport model is based on an iterative-alternating-direction-implicit mathematical solution of the ground-water-flow equation coupled with a method-of-characteristics solution of the solute-transport equation. The model assumes conservative (nonreactive) transient transport of DIMP and steady-state ground-water flow. In the model simulations, a bentonite barrier was assumed that was impermeable and penetrated the entire saturated thickness of the aquifer. Ground water intercepted by the barrier was assumed to be pumped by wells located south (upgradient) of the barrier, to be treated to remove DIMP, and to be recharged by pits or wells to the aquifer north (downgradient) of the barrier. The amount of DIMP transported across the northern boundary of the arsenal was substantially reduced by a ground-water-barrier system of this type. For a 1,500-foot-long bentonite barrier located along the northern boundary of the arsenal near D Street, about 50 percent of the DIMP that would otherwise cross the boundary would be intercepted by the barrier. This barrier configuration and location were proposed by the U.S. Army. Of the ground water with DIMP concentrations greater than 500 micrograms per liter, the safe DIMP-concentration level determined by the U.S. Army, about 72 percent would be intercepted by the barrier system. The amount of DIMP underflow intercepted may be increased to 65 percent by doubling the pumpage, or to 73 percent by doubling the length of the barrier. (Kosco-USGS)
W80-05297

**WATER IN THE PENSACOLA, FLORIDA, AREA.**
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2A.
W80-05298

**A ONE-DIMENSIONAL, STEADY-STATE, DISSOLVED-OXYGEN MODEL AND WASTE-LOAD ASSIMILATION STUDY FOR SOUTH FORK WILDCAT CREEK, CLINTON COUNTY, INDIANA,**
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 6A.
W80-05299

**A ONE-DIMENSIONAL, STEADY-STATE, DISSOLVED-OXYGEN MODEL AND WASTE-LOAD ASSIMILATION STUDY FOR CEDAR CREEK, DEKALB AND ALLEN COUNTIES, INDIANA,**
Geological Survey, Indianapolis, IN. Water Resources Div.
W. G. Wilber, J. G. Peters, M. A. Ayers, and C. G. Crawford.
Geological Survey open-file report 79-1062, June 1979. 79 p, 30 Fig, 11 Tab, 47 Ref.

Descriptors: *Model studies, *Dissolved oxygen, *Waste assimilative capacity, *Water quality, *Indiana, Streams, Streamflow, Low-flows, Effluents, Forecasting, Water quality standards, Water pollution, Waste water disposal, Reaeration, Waste water treatment, Mathematical models, Biochemical oxygen demand, Nitrification, Ammonia, Nitrates, Nutrients, *Dekalb County(Ind), *Allen County(Ind), *Cedar Creek(Ind).

A digital model calibrated to conditions in Cedar Creek was used to develop alternatives for future waste loadings that would be compatible with Indiana stream water-quality standards defined for two critical hydrologic conditions, summer and winter low flows. The model indicates that the dissolved-oxygen concentration of the Auburn wastewater effluent and nitrification are the most significant factors affecting the dissolved-oxygen concentration in Cedar Creek during summer low flows. The observed dissolved-oxygen concentration of the Auburn wastewater effluent was low and averaged 30 percent of saturation. Projected nitrogenous biochemical-oxygen demand loads, from the Indiana State Board of Health, for the Auburn and Waterloo wastewater-treatment facilities will result in violations of the current instream dissolved-oxygen standard (5 mg/l), even with an effluent dissolved-oxygen concentration of 80 percent saturation. Natural streamflow for Cedar Creek upstream from the confluence of Willow and Little Cedar Creeks is small compared with the waste discharge, so benefits of dilution for Waterloo and Auburn are minimal. The model also indicates that, during winter low flows, ammonia toxicity, rather than dissolved oxygen, is the limiting water-quality criterion in the reach of Cedar Creek downstream from the wastewater-treatment facility at Auburn and the confluence of Garrett ditch. Ammonia-nitrogen concentrations predicted for 1978 through 2000 downstream from the Waterloo wastewater-treatment facility do not exceed Indiana water-quality standards for streams. Calculations of the stream's assimilative capacity indicate that future waste discharge in the Cedar Creek basin will be limited to the reaches between the Auburn wastewater-treatment facility and County Road 68. (Kosco-USGS)
W80-05302

**A ONE-DIMENSIONAL, STEADY-STATE, DISSOLVED-OXYGEN MODEL AND WASTE-LOAD ASSIMILATION STUDY FOR WILDCAT CREEK, HOWARD COUNTY, INDIANA,**
Geological Survey, Indianapolis, IN. Water Resources Div.
C. G. Crawford, W. G. Wilber, and J. G. Peters.
Available from: OFSS, USGS Box 25425, Fed. Ctr. Denver, CO 80225. Paper copy $8.50, Microfiche $3.50. Geological Survey open-file report 79-1252, July 1979. 60 p, 19 Fig, 13 Tab, 53 Ref.

Descriptors: *Model studies, *Dissolved oxygen, *Waste assimilation capacity, *Water quality, *Indiana, Streams, Streamflow, Low flows, Reaeration, Effluents, Forecasting, Water quality standards, Water pollution, Waste water disposal, Mathematical models, Waste water treatment, Biochemical oxygen demand, Nitrification, Ammonia, Nitrates, Nutrients, *Howard County(Ind), *Wildcat Creek(Ind).

The Indiana State Board of Health is developing a water-quality management plan that includes establishing limits for wastewater effluents discharged into Indiana streams. A digital model calibrated to conditions in Wildcat Creek was used to predict alternatives for future waste loadings that would be compatible with Indiana stream water-quality standards defined for two critical hydrologic conditions, summer and winter low flows. The model indicates that benthic-oxygen demand is the most significant factor affecting the dissolved-oxygen concentrations in Wildcat Creek during summer low flows. The Indiana stream dissolved-oxygen standard should not be violated if the Kokomo wastewater-treatment facility meets its current National Pollution Discharge Elimination System permit restrictions (average monthly 5-day biochemical-oxygen demand of 5 milligrams per liter and maximum weekly 5-day biochemical-oxygen demand of 7.5 milligrams per liter) and benthic-oxygen demand becomes negligible. Ammonia-nitrogen toxicity may also be a water-quality limitation in Wildcat Creek. Ammonia-nitrogen waste loads for the Kokomo wastewater-treatment facility, projected by the Indiana State Board of Health, will result in stream ammonia-nitrogen concentrations that exceed the State standard (2.5 milligrams per liter during summer months and 4.0 milligrams per liter during winter months). (Kosco-USGS)
W80-05303

**U.S. HEAVY METAL LOADINGS TO THE GREAT LAKES: ESTIMATES OF POINT AND NONPOINT CONTRIBUTIONS,**
Great Lakes Basin Commission, Ann Arbor, MI.
For primary bibliographic entry see Field 6A.
W80-05335

**DATA PROCESSING AND ANALYSIS FROM H-F RADAR DATA OBTAINED IN COOK INLET ALASKA DURING SUMMERS 1977 AND 1978,**
National Oceanic and Atmospheric Administration, Rockville, MD. Wave Propagation Lab.
For primary bibliographic entry see Field 5A.
W80-05337

**A NEW TECHNIQUE FOR MEASURING TIDAL CURRENTS USING A TWO-SITE HF DOPPLER RADAR SYSTEM,**
National Oceanic and Atmospheric Administration, Rockville, MD. Wave Propagation Lab.
For primary bibliographic entry see Field 5A.
W80-05338

**THE INTERACTION OF OIL WITH SEA ICE IN THE ARCTIC OCEAN,**
Washington Univ., Seattle. Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W80-05340

**DYNAMICS OF NEAR-SHORE ICE,**
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5A.
W80-05341

**CURRENT MEASUREMENTS IN POSSIBLE DISPERSAL REGIONS OF THE BEAUFORT SEA,**
Washington Univ., Seattle. Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W80-05342

**NORTHWEST GULF OF ALASKA SHELF CIRCULATION,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 5A.
W80-05343

**BRISTOL BAY OCEANOGRAPHIC PROCESSES (B-BOP),**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 5A.
W80-05344

**CIRCULATION AND WATER MASSES IN THE GULF OF ALASKA,**
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5A.
W80-05345

**NEAR-SHORE METEOROLOGY,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 5A.
W80-05346

**OBSERVATIONS OF MESOSCALE WINDS IN LOWER COOK INLET, ALASKA - MARCH 1978,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 5A.
W80-05347

**THE RESPONSE OF COASTAL WINDS AT ALBATROSS BANKS, LOWER COOK INLET, AND HINCHINBROOK ENTRANCE TO A PASSING SYNOPTIC DISTURBANCE - PRELIMINARY ANALYSIS,**
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 5A.
W80-05348

**BOTTOM AND NEAR-BOTTOM SEDIMENT DYNAMICS IN LOWER COOK INLET,**
Geological Survey, Menlo Park, CA. Branch of Pacific-Arctic Marine Geology.
D. A. Cacchione, and D. E. Drake.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 505-546, October 1979. 13 Fig, 3 Tab, 14 Ref, Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Sediment transport, *Erosion, *Sand waves, Hazards, Environmental effects, Oil pollution, Offshore platforms, Resources development, Alaska, Paths of pollutants, *Outer Continental Shelf, Cook Inlet, Petroleum development.

An intensive field investigation was carried out on near-bottom and bottom sediment movement within a small area of lower Cook Inlet that contains bedforms of multiple scales. This research effort focuses on the mechanisms which control the transport of sediments, the temporal variability of this transport and the contrasts in transport at trough and crest locations of the largest bed features. The major objective, to provide a spatial and temporal description of bottom sediment movement in this highly complex sand wave environment, was motivated by the need to assess the potential environmental hazards posed by excessive erosion and sand wave migration. High rates of sediment transport and erosion are potentially hazardous to sea floor installations. Additionally, waste materials introduced into the bottom environment by drilling operations and oil spilled during recovery accidents will be in part transported by the bottom currents. If oil-contaminated sediments are effectively transported large distances along the bottom, and resuspended well up into the overlying water column, the spatial extent of harmful effects from these pollutants could be considerably greater than otherwise anticipated. (Sinha-OEIS)
W80-05349

**MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA,**
Rand Corp., Santa Monica, CA.
For primary bibliographic entry see Field 5A.
W80-05350

**METEOROLOGY OF THE ALASKAN ARCTIC COAST,**
Washington Univ., Seattle. Polar Science Center.
For primary bibliographic entry see Field 5C.
W80-05351

**COMPARISON BETWEEN GEOSTROPHIC WINDS DERIVED FROM THE STANDARD PRESSURE MEASUREMENT NETWORK AND THE AIDJEX NETWORK,**
Washington Univ., Seattle. Polar Science Center.
For primary bibliographic entry see Field 5A.
W80-05352

**OIL POOLING UNDER SEA ICE,**
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5A.
W80-05356

**THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE,**
Flow Research Co., Kent, WA.
For primary bibliographic entry see Field 5A.
W80-05357

**BEAUFORT AND CHUKCHI SEA ICE MOTION. PART 1: PACK ICE TRAJECTORIES,**
Flow Research Co., Kent, WA.
For primary bibliographic entry see Field 5A.
W80-05358

**BEAUFORT AND CHUKCHI SEA ICE MOTION. PART 2: ONSET OF LARGE SCALE CHUKCHI SEA ICE BREAKOUT,**
Flow Research Co., Kent, WA.
For primary bibliographic entry see Field 5A.
W80-05359

**ICE BREAKOUT IN THE BERING STRAIT,**
Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.
For primary bibliographic entry see Field 5A.
W80-05360

**ARCTIC OIL SPILL SCENARIOS - OUTLINE,**
Flow Research Co., Kent, WA.
For primary bibliographic entry see Field 5A.
W80-05361

**THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE - TASK 1,**
ARCTEC, Inc., Columbia, MD.
For primary bibliographic entry see Field 5A.
W80-05362

**ENERGY FACILITY SITING IN THE URBAN COASTAL ZONE: COMPATIBLE OR NOT,**
Princeton Univ., NJ.
For primary bibliographic entry see Field 6E.
W80-05365

**FEDERAL CONTROL OF WATER POLLUTION - AN OUNCE OF PREVENTION IS WORTH A POUND OF CURE,**
Levine and Krom, Beverly Hills.
For primary bibliographic entry see Field 6E.
W80-05374

**LIQUEFIED NATURAL GAS TERMINAL SITING IN THE CALIFORNIA COASTAL ZONE: THE SCOPE OF PERMISSIBLE STATE AUTHORITY,**
For primary bibliographic entry see Field 6E.
W80-05383

## 5C. Effects Of Pollution

**LIFE CYCLE, ECOLOGY, AND MANAGEMENT CONSIDERATIONS OF THE GREEN FILAMENTOUS ALGA, PITHOPHORA,**
Purdue Univ., Lafayette, IN. Water Resources Research Center.
C. A. Lembi, N. L. Pearlmutter, and D. F. Spencer.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-185333, Price codes: A06 in paper copy, A01 in microfiche. Technical Report No 130, April 1980. 97 p, 46 Fig, 23 Tab, 87 Ref. OWRT B-081-IND(2).

Descriptors: *Pithophora, *Life cycles, *Aquatic algae, *Akinetes, Cladophora, Aquatic weed control, Copper sulphate, Ecology, Filamentous alga, Spores.

Pithophora, a green filamentous, spore-forming alga in the order Cladophorales, forms infestations of thick free-floating mats in small impoundments, shallow lakes, and coves and channels of larger lakes and reservoirs throughout the midwest and southeastern United States. The purpose of the research was to obtain data on the biology of Pithophora in order to establish a basis for management recommendations. The life cycle of Pithophora oedogonia consists of two stages: branching filamentous cells and akinetes. Both cell types are enclosed by a thick cell wall composed primarily of cellulose with additional amounts of sugars, amino sugars, and proteins, the latter being concentrated in the outer cell wall layer. Chiten comprises 6 percent of the cell wall by weight and is localized in the outer wall layers, cross wall disks and associated bands. Akinetes that form in the free floating mats in the fall reach their highest number in the winter, and germinate at 20C water temperature. Akinete formation is probably due to nitrogen depletion rather than cold temperature, are high in number in the hydrosoil and retain viability to depths of 10 cm. in the hydrosoil. Specific management techniques for control of Pithophora are being studied and will be reported in a subsequent publication. (Wiersma-Ind)
W80-05101

**NITROGEN AND PHOSPHORUS HYDROCHEMISTRY IN LAS VEGAS WASH,**
Nevada Univ. System, Reno. Water Resources Center.
A. Schmidt, and J. W. Hess.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-185325, Price codes: A04 in paper copy, A01 in microfiche. Publication No 41063, March 1980. 71 p, 4 Fig, 7 Tab, 31 Ref, 5 Append. OWRT A-082NEV(1).

Descriptors: *Nitrogen, *Phosphorus, *Groundwater movement, *Nutrients, Urbanization, Test wells, Water levels, Water pollution, Waste water(Pollution), Aquatic plants, Water sampling, Bottom sediments, Eutrophication, Lake Mead.

The sources of nitrogen and phosphorus nutrient species, the chemical reactions occurring, and the parameters of nutrient uptake were studied for the Las Vegas Wash hydrologic system. Las Vegas

Wash, a natural drainage channel running from Las Vegas Valley to Lake Mead-Colorado River, has been the site of extensive urbanization in the past 20 years. The waste water increases associated with this development resulted in declining surface and groundwater quality and eutrophication of the Lake. Stricter effluent nutrient concentration standards were imposed and the effect of these standards is assessed. Water level measurements were taken in 14 wells in the area using a hand-held tape measure. Changes in water levels from the summer of 1975 to the summer of 1978 were determined. No area-wide improvement in shallow groundwater quality was found but several wells did indicate slow improvement. The wash was divided into two reaches to study flow budgeting. Results show that the inflow of groundwater above Pabco Road (Reach 1) is nearly zero while inflow below Pabco Road (Reach 2) is approximately 20 cfs. Salt input to Reach 1 has decreased while input to Reach 2 has remained constant. Also it appears that aquatic vegetation or bottom sediments in Reach 2 are accumulating P04(-3). Surface water quality has shown gradual improvement. (Seigler-IPA)
W80-05107

**MODEL PREDICTIONS OF EFFECTS OF IMPOUNDMENT ON PARTICULATE ORGANIC MATTER TRANSPORT IN A RIVER SYSTEM,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 2J.
W80-05116

**VERIFICATION OF A YORK RIVER ECOSYSTEM MODEL,**
Virginia Inst. of Marine Science, Gloucester Point.
P. V. Hyer.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 246-252, 1978. 1 Fig, 2 Tab, 4 Ref.

Descriptors: *Estuaries, *Ecosystems, *Nutrients, *Model studies, Mathematical models, Biochemistry, Phytoplankton, Phosphorus, Nitrogen, Ammonia, Chlorophyll, Algae, Light, Photosynthesis, Water pollution, Water quality, Water pollution effects, Water pollution sources, *York River(VA).

The York River is a tidal estuary in a rural setting, where the chief occupations are farming, logging, and commercial fishing. Precipitation is lowest in September to January and highest in July and August, when thunderstorms abound. These storms, however, contribute relatively little runoff. The water temperature reaches 28C and sometimes 30C in late summer, but ice forms in about one winter out of every two. Summer is the critical time for water quality. The York is more than two miles wide in places, and its greatest depth approaches 30 meters. Therefore, a quasi three-dimensional model was decided on, with three lateral segments and two layers per reach. Observed chlorophyll concentrations ranged from 4-10 micrograms per liter, well below nuisance levels. It was found that arbitrarily doubling or tripling nutrient loadings input to the model could not trigger a bloom. Light was the most important factor controlling phytoplankton growth, followed by nitrogen availability. Oxygen levels were above five parts per million except in the deeper layer near the mouth, where a relatively stagnant region was created and oxygen concentration fell to about two parts per million. This natural phenomenon is not affected by point or nonpoint sources. (See also W80-05159) (Sims-ISWS)
W80-05180

**SIMULATION OF ALGAL GROWTH IN THE CHOWAN RIVER,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
D. N. Contractor.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 253-264, 1978. 8 Fig, 7 Ref.

Descriptors: *Algae, *Rivers, *Virginia, *North Carolina, *Model studies, Mathematical models, Nitrogen, Nutrients, Ammonia, Oxygen, Biochemical oxygen demand, Chemical oxygen demand, Water quality, Water pollution, Water pollution effects, *Chowan River(VA, NC).

The Chowan River watershed lies in the southeastern part of Virginia. The Blackwater and Nottoway rivers form a confluence at the state line with North Carolina. The Meherrin River joins the Chowan River in a second confluence a few miles downstream of the first confluence. In the early 1970s, severe algal blooms occurred in the lower reaches of the Chowan River. A cooperative study of algal growth in the river was initiated in 1974. This paper presented some results of the mathematical model developed for the watershed above Holiday Island. (See also W80-05159) (Sims-ISWS)
W80-05181

**THE STOCHASTIC VARIATION OF INSTREAM VALUES IN RIVERS,**
Washington State Dept. of Ecology, Olympia.
R. T. Milhous, and K. D. Bovee.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 630-637, 1978. 3 Fig, 1 Tab, 2 Ref.

Descriptors: *Aquatic environment, *Mathematical models, *Habitat improvement, *Rivers, Stochastic processes, Fisheries, Water quality, Velocity, Analytical techniques, Water utilization, Statistical methods, Probability, Water temperature, Artificial substrates, Depth, Chinook salmon, Instream values.

An important part of the management of water resources is the allocation of water between out-of-stream uses and instream uses. In the context used, instream uses are all uses of water in the stream channel, except the production of hydroelectric power, with special attention given to the recreation and fisheries use of water instream. At this time very little work on instream flows has been done which describes the variation of the instream habitat over time; consequently, the information in this paper is incomplete and more in the nature of what could be done instead of what has been done. Ideas were presented as just that--ideas which can either be rejected in total, modified or expanded upon as an attempt is made to apply the concepts of stochastic process to instream flow-produced benefits. The use of statistics and stochastic approaches was in two areas: (1) the development of functional relationships between physical properties of streamflow and the biologic needs of a species of fish or a type of water-based recreation, and (2) the variation of the quality of the habitat over time. It was suggested that by combining a stochastic habitat model, as a driving variable for density dependence, with a population model, the observed variation in natural population of fish in a stream can be simulated. (See also W80-05159) (Humphreys-ISWS)
W80-05217

**GROWTH AND PRIMARY PRODUCTIVITY OF MARINE MACROPHYTES EXPOSED TO DOMESTIC SEWAGE EFFLUENTS,**
California Univ., Irvine. Dept. of Ecology and Evolutionary Biology.
A. C. Kindig, and M. M. Littler.
Marine Environmental Research, Vol 3, p 81-100, 1980. 7 Fig, 4 Tab, 26 Ref. OWRT A-054-CAL(11).

Descriptors: *Marine algae, *Growth rates, *Sewage effluents, Primary productivity, Domestic wastes, Primary treatment, Secondary treatment, Chlorination, Metabolism, Adaptation, Biomass, Photosynthesis, *Bossiella, *Lithothrix, *Corallina, *Amphiroa, *Acclimation.

This study provides the first response data for ten Southern California macrophytes exposed to untreated, primary, secondary and secondary chlorinated sewage effluent during long-term culture studies in the laboratory as well as short-term metabolic studies in the field and in the laboratory. Bossiella orbigniana, Lithothrix aspergillum and Corallina officinalis had relatively broad homeostatic capabilities and enhanced net production rates when exposed to primary treated sewage. In the long-term cultures, Amphiroa zonata, B. orbigniana and C. officinalis all demonstrated enhanced growth in the presence of primary sewage. Chlorination of effluent had only a short-term negative effect; i.e. species' responses to secondary and secondary chlorinated sewage were virtually identical beyond the second week in culture. Three populations of C. officinalis var. chilensis with differing pollution histories showed a tolerance to sewage corresponding to the extent of previous exposure, indicating that this species may be able to acclimate physiologically to sewage stress. The more sewage-tolerant macrophytes displayed lower photosynthetic quotient values during exposure to effluent than those possessing little tolerance to sewage. (Deal-ISWS)
W80-05250

**THE FISH COMMUNITY OF LAKE SUPERIOR,**
Ontario Ministry of Natural Resources, Maple. Fish and Wildlife Research Branch.
A. H. Lawrie.
Journal of Great Lakes Research, Vol 4, No 3-4, p 513-549, December 1978. 11 Fig, 18 Tab, 137 Ref, 1 Append.

Descriptors: *Lake Superior, *Fish, *Lake fisheries, *Surveys, Lakes, Fish populations, Lake Trout, Fish harvest, Salmon, Fish management, Lampreys, Fish establishment, Water pollution, Freshwater fish, Data collections, Lake Whitefish.

Lake trout, lake whitefish, and their relatives characterize the fish community of oligotrophic Lake Superior. That community has been substantially altered by the direct and indirect effects of man's activities, generally in the direction of reduced diversity and depletion of many fish stocks. Long-continued heavy fishing, predation by and competition from invading exotic species, and environmental degradation have all played a role as have efforts to rehabilitate the community by introducing hatchery-reared fish of desired species. Community responses to these influences have been complex, and although some are obvious and can be quantitatively modeled others reflect subtler, interactive responses to primary changes in abundance and size composition of various components of the community. Among the stresses whose roles remain to be clearly defined are the anthropogenic contaminants now known to occur, if only in small concentrations, in virtually all species. Although their impact on the welfare of individual fish stocks cannot be precisely defined at the moment, their presence at all is profoundly disturbing. (Humphreys-ISWS)
W80-05266

**GROWTH, CHLOROPHYLL AND MINERAL NUTRIENT STUDIES ON PHALARIS ARUNDINACEAE L. IN THREE SCOTTISH LOCHS,**
Dundee Univ. (Scotland). Dept. of Biological Sciences.
For primary bibliographic entry see Field 2I.
W80-05319

**INVASION, POPULATION DYNAMICS AND ELEMENTAL ACCUMULATION OF CORBICULA FLUMINEA IN THE NEW RIVER AT GLEN LYN, VIRGINIA,**
East Tennessee State Univ., Johnson City. Dept. of Environmental Health.
J. H. Rodgers, Jr., D. S. Cherry, K. L. Dickson, and J. Cairns, Jr.
In: Proceedings, First International Corbicula Symposium Texas Christian University, Fort Worth, October 13-15, 1977. p 99-110 (1977). 4 Fig, 2 Tab, 27 Ref. OWRT B-101-VA(2).

Descriptors: *Toxicity, Population dynamics, Bioassays, *Invasion, Mercury, Arsenic, Selenium, *Heated water, *Powerplants, Virginia, Invasion rate, Corbicula, *Asiatic Clam, Bioaccumulation, *New River(VA), *Glen Lyn(VA).

Corbicula fluminea has apparently successfully invaded the New River, and population densities of about 1,000 individuals per square meter have become established after three years. The influence of thermal effluent from a coal-fired power plant on population numbers was observed after an unusually cold winter had caused a severe decline in density in areas unaffected by heated water. Numbers remained essentially constant in the thermal effluent during the winter months. After the following spawning season, population densities outside of the thermal effluent recouped, although size classes were altered. Bioaccumulation of elements in soft body parts of Corbicula was generally intermediate in comparison to sediment and water. Of several potentially toxic elements, only selenium, mercury, and arsenic were found in soft body tissues in concentrations of less than 1 ppm. (Cherry-Virginia)
W80-05332

**EXPERIMENTS IN RECYCLING SWINE MANURE IN FISHPONDS,**
Illinois Natural History Survey Kinmundy.
D. H. Buck, R. J. Baur, and C. R. Rose.
Food and Agriculture Organization of the United Nations, Rome, Italy. Paper FIR: AQ/Conf/76/E 29, February 1976, 5 p. OWRT A-083-ILL(2).

Descriptors: *Swine manure, *Recycling, *Fish farming, *Fish, *Waste treatment, *Aguiculture, *Farm wastes, Waste management, *Buffalo fish, Chinese carps, Polyculture.

This is believed to have been the first attempt in North America to utilize certain Asian cultures and techniques in the solution of such problems as animal waste management, pollution control, and the production of protein. Two small Illinois ponds of similar size received nearly identical stockings of fish (three Chinese carps, common carp, largemouth bass, a hybrid buffalo fish and channel catfish), but differing amounts of swine manure. One pond (0.127 ha) received the total wastes from five growing pigs (about 39 pigs/ha of water area), the other pond (0.121 ha) received the wastes from eight pigs (66 pigs/ha). Two consecutive lots of pigs were fattened during the experiment. Water levels were lowered at mid-season to improve natural circulation, but conditions were otherwise static, with no artificial circulation or aeration. Over a fish-growing period of about 170 days (May to October 1975) the net increments in fish biomass were at the rates of 2971 kg/ha in the 0.127-ha pond, and 3834 kg/ha in the 0.121-ha pond. The high production of fish was attributed to: (1) the high quality of the swine rations; (2) an efficient density of stocking ratio of fish species; and (3) effective water level management. A beneficial influence by the fish population on water quality was indicated by continuously adequate levels of dissolved oxygen, and final BODs in the range of 8-12 mg/l.
W80-05333

**OIL SPILL VULNERABILITY, COASTAL MORPHOLOGY, AND SEDIMENTATION OF KOTZEBUE SOUND,**
South Carolina Univ., Columbia. Div. of Coastal Research.
M. O. Hayes, and C. Ruby.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VII, Transport, p 115-170, October 1979. 9 Fig, 5 Tab, 15 Ref, Append. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado.

Descriptors: *Oil spills, *Environmental effects, *Water pollution effects, *Baseline studies, Path of pollutants, Sedimentation, Exploration, Movement, Alaska, Resources development, *Outer Continental Shelf, Coastal morphology, Vulnerability index, Kotzebue Sound(AK).

The potential for oil spills in Alaskan waters is increasing as exploration and development continue to escalate. There is a complex interaction of marine processes during an oil spill which can make it extremely difficult to predict the track and dispersal pattern of an oil spill. However, numerous case studies permit the construction of an oil spill vulnerability scale which is based primarily on the longevity of spilled oil within each geomorphic environment, and the biologic sensitivity and natural cleaning ability of those environments. This scale is here modified for Kotzebue Sound. The scale has been devised on the basis of case studies and a careful study of the literature, and is based primarily on the longevity of oil in each subenvironment, which is generally a function of the intensity of the marine processes, sediment size and transport trends. The biologic sensitivity has also been utilized to modify the ratings of the various environments. Coastal environments are listed and discussed in order of increasing vulnerability of oil spills. (Sinha-OEIS)
W80-05339

**METEOROLOGY OF THE ALASKAN ARCTIC COAST,**
Washington Univ., Seattle. Polar Science Center.
T. L. Kozo, and R. A. Brown.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 1-45, October 1979. 28 Fig, 20 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-5-022-67.

Descriptors: *Meteorology, *Winds, *Baseline studies, *Ice, Water pollution effects, Environmental effects, Resources development, Alaska, Arctic, Path of pollutants, Coasts, *Outer Continental Shelf, Petroleum development.

Surface winds, temperature and atmospheric pressures along the Alaskan arctic coast were measured and analyzed to derive the wind field responsible for near shore (water depths to 20 m) surface water movement. Results of this study have shown that the surface wind field in spring and summer is strongly correlated at measuring stations separated by distances up to 100 km. This strong mesoscale correlation implies that a minimum of surface wind measurements points could provide a reasonable data set for coastal current trajectory studies. The effect of coastal winds on the summer nearshore circulation has relevance to transport of detritus, biota, spilled oil, and small ice floes. The sea breeze promotes barrier island lagoon flushing, and upwelling by maintaining persistent NE to E surface winds. Any attempt to predict current trajectories must include a prediction of the surface wind field. The summer main ice pack edge serves as a source for small ice floes which are driven into the nearshore region by surface wind and resultant currents. Uncovered sea bed pipelines in trenches running from the offshore islands to the coast will be susceptible to ice damage when floes move into shallow water with a northerly velocity component. Oil slicks that may result from such accidents will also be strongly influenced by the wind regime. (Sinha-OEIS)
W80-05351

**CHARACTERIZATION OF THE NEARSHORE HYDRODYNAMICS OF AN ARCTIC BARRIER ISLAND-LAGOON SYSTEM,**
Alaska Univ., Fairbanks. Geophysical Inst.
J. B. Matthews.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 57-97, October 1979. 19 Fig. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-5-022-56.

Descriptors: *Hydrodynamics, *Circulation, *Water quality, Barrier islands, Lagoons, Oil pollution, Water pollution effects, Environmental effects, Baseline studies, Resources development, Arctic, Alaska, Ecosystems, Lagoons, Marine environment, *Outer Continental Shelf, Petroleum development, Environmental impact.

This project provides sea level, temperature, salinity, current speed and direction data for stations within the proposed Beaufort Sea lease area. The lagoon waters are wind-driven in the open water season with currents in the same direction as the wind and with 3% the wind speed. Winds of 12 m/sec during a storm resulted in observed currents in Simpson Lagoon of 40 cm/sec. The sea level changes were about 1 m due to wind set-up whereas tidal ranged are from 10-20 cm. Barometric pressure does not have much influence on sea level during the open water season. Currents under ice were generally less than 10 cm/sec. The overall ecosystem processes study addresses only those processes which are anticipated to be impacted by activities related to petroleum development. Water quality and circulation, during both the open-water and ice-covered seasons, are a primary driving mechanism of the ecosystem. Water quality influences biological growth and migration routes for fish. Water circulation can carry pollutants and nutrients and is influenced by man-made changes to the environment, such as building of causeways, drilling pads and pipelines. One must know the existing water quality and circulation before oil development begins in order to assess probable impacts resulting from such activities. (Sinha-OEIS)
W80-05353

**SOURCES, TRANSPORT PATHWAYS, DEPOSITIONAL SITES AND DYNAMICS OF SEDIMENTS IN THE LAGOON AND SHALLOW MARINE REGION, NORTHERN ARCTIC ALASKA,**
Alaska Univ., Fairbanks. Inst. of Marine Science.
A. S. Naidu, and M. D. Sweeney.
In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for year ending March 1979. Vol VIII, Transport, p 98-181, October 1979. 6 Fig, 17 Tab, 36 Ref. NOAA, Environmental Research Laboratories, Outer Continental Shelf Environmental Assessment Program, Boulder, Colorado. NOAA-03-5-022-56.

Descriptors: *Sediment transport, *Heavy metals, Oil spills, *Ecosystems, Baseline studies, *Sedimentation, Resources development, Water pollution effects, Environmental effects, Arctic, Alaska, Lagoons, Marine environment, *Outer Continental Shelf, Beaufort Sea, Petroleum development.

The major objectives of this program are to understand the dynamics of sedimentation, to characterize benthic substrate habitats, and to elucidate the sources and depositional sites of terrigenous particles in the lagoon and adjacent shelf area of north arctic Alaska. Additional goals include completion of collection of baselines of a suite of heavy metals relative to sediments of the Beaufort Sea, understanding of the geochemical partitioning of the heavy metals in various sediment phases, and estimation of the rate of sedimentation. Compilation of all available data on textural attributes of surficial sediments of the Beaufort Sea has been completed. Maps generated to display regional variations in the gross lithology and the various statistical grain size parameters will be useful to biologists interested in characterizing the benthic habitats of the Beaufort Sea, as well as to geologists who are concerned with elucidation of Holocene depositional history of the Beaufort Sea. The baseline data on heavy metals in sediments should help in detection of any large scale perturbations in environments that might result from discharge of chemical pollutants into the nearshore areas. The baseline lithology maps should serve a useful purpose in detecting any changes in sediment budgets (and by implication benthic habitats) resulting from petroleum-related activities such as dredging, causeway construction and possible gravel/sand exploitation. (Sinha-OEIS)
W80-05354

## 5D. Waste Treatment Processes

**EVALUATION OF MEMBRANE PROCESSES AND THEIR ROLE IN WASTEWATER RECLAMATION,**
Orange County Water District, Fountain Valley, CA.
D. G. Argo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-185754, Price codes: A12 in paper copy, A01 in microfiche. Final Report prepared for the Office of Water Research and Technology, November 1979. 234 p. OWRT C-80159-R (No 8520)(1).

Descriptors: *Advanced wastewater treatment, *Water reuse, *Facilities, Water reclamation, Trace organics, Reverse osmosis, Demineralization, Biological treatment, Orange County Water District(California), Costs, Facilities, Design.

Water Factory 21 (WF-21) in Orange County, California, is a 15 mgd advanced wastewater treatment (AWT) plant designed to reclaim biologically treated municipal wastewater for injection into a seawater barrier system. Processes included are lime treatment, air stripping, filtration, activated carbon adsorption, reverse osmosis (RO), and chlorination. The effectiveness of each process is presented, with emphasis on demineralization, ozone and biologically activated carbon, and ultrafiltration. The data show that the combination of processes used at WF-21 is capable of producing a very high quality water. All contaminants were reduced below national interim primary drinking water regulation maximum contaminant levels at least 98% of the time. Over 100 trace organic substances were found in the influent to WF-21, and of these about 30 were regularly monitored. The two processes found most effective in removal of specific organics were air stripping and activated carbon adsorption. Overall removals generally exceeded 90%. Viruses were routinely found in WF-21 influent. On two occasions viruses were detected in the activated carbon effluent during upflow operation of the columns. Following modifications, no viruses have ever been found in the effluent from the activated carbon columns or that from the RO system. AWT cost at WF-21 is $665/mil gal and the additional cost of RO demineralization is $621/mil gal. These figures include all operation and maintenance costs as well as amortization of capital.
W80-05105

**VIRUS REMOVAL BY ADVANCED WASTEWATER TREATMENT.**
Orange County Water District, Fountain Valley, CA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-188386, Price codes: A09 in paper copy, A01 in microfiche. Final Report, Prepared for the Office of Water Research and Technology, October 1979. 139 p, 36 Fig, 60 Tab, 45 Ref, 5 Append. OWRT C-80159-R (No 8520)(2), 14-34-0001-8520.

Descriptors: *Viruses, *Waste water treatment, *Chlorination, *Reverse osmosis, Lime, Aluminum, California, Activated carbon, Water purification, Assay, Analytical techniques, Sewage effluents, Diseases, Public health, Orange County Water District(Cal).

An enteric virus monitoring program was performed during 1975-1979 at Water Factory 21 in the Orange County Water District in California to develop sensitive quantitative determination methods for enteric viruses, to monitor the plant's chlorinated effluent for enteric viruses, and to evaluate the effectiveness of the plant's individual unit processes. Water Factory 21 represents the state-of-the-art technology in water reclamation and incorporates a 5 mgd reverse osmosis plant. Eleven experiments were performed to develop an optimized methodology for concentrating enteric viruses from plant effluents. An adsorption procedure was selected that involves adjusting the sample to a pH of 3.5 and adding Al(III). The Filterite filter, found to be the best of four studied adsorbents, was used in calibration tests at the various sites to determine the volume that could be processes by the adsorbent. The liquid culture assay system using cytopathic effects with Buffalo Green monkey kidney cells and human carcinoma cells was found to recover the largest number of isolates. Assays were performed on 207 samples from various treatment processes. Lime treatment was found to have a 98 to 99.9% removal capability. No positive samples were found in the reverse osmosis influent or effluent or in the granular activated carbon unit. Of 122 chlorinated effluent samples assayed, 2 were positive and both were associated with atypical operating conditions. (Seigler-IPA)
W80-05106

**WASTEWATER TREATMENT IN COLD REGIONS BY OVERLAND FLOW,**
Cold Regions Research and Engineering Lab., Hanover, NH.
C. J. Martel, T. F. Jenkins, and A. J. Palazzo.
CRREL Report 80-7, February 1980. 18 p, 6 Fig, 10 Tab, 16 Ref.

Descriptors: *Cold regions, *Overland flow, *Waste water treatment, Sewage treatment, Biochemical oxygen demand, Seasonal, Winter, Forages, New Hampshire, Subsurface runoff, Water pollution, Snowmelt, Nitrogen, Water storage.

Three types of water, primary effluent, secondary effluent, and tapwater, were applied to separate sections of a pilot-scale overland flow site in Hanover, New Hampshire, to evaluate the performance of overland flow waste water treatment in cold regions. The study area has a mean annual temperature of 7C and the temperature falls below 0C approximately 160 days/year. The test site was 30.5 m long, 8.8 m wide, with a 5% slope. Primary and secondary waste water were obtained from pilot plant units and tapwater was supplied by the Hanover water supply system. Applications were made daily at 0.25 cm/hr for an average weekly application rate of 5 cm/week. Measurements were taken for one year of surface runoff, subsurface flows, precipitation, evaporation, percolation, soil temperature, and meteorological parameters. Results show that overland flow is a successful treatment method for primary and secondary effluent during all seasons of the year except winter. Runoff from the primary section exceeded the 30-mg/liter BOD standard for 82 days during winter, however, runoff from the secondary section did meet standards for the same period. The tapwater section, used as a control, showed no pollutants. Nitrate was the most difficult form of nitrogen to remove while ammonia was the easiest. Excellent forage yield was observed for both of the waste water sections and winter applications caused only minor injury. Storage prediction times from the EPA-1 computer program appear to be adequate. (Seigler-IPA)
W80-05112

**ULTRAFILTRATION TREATMENT OF POULTRY PROCESSING WASTEWATER AND RECOVERY OF A NUTRITIONAL BY-PRODUCT,**
North Carolina State Univ. at Raleigh. Dept. of Poultry Science.
J. C. H. Shih, and M. B. Kozink.
Poultry Science, Vol 59, No 2, p 247-252, Feb 1980. 4 Fig, 3 Tab, 12 Ref. OWRT A-100-NC(2), 14-34-0001-8035.

Descriptors: *Poultry processing, Water reuse, By-product recovery, Membrane flux, *Waste water treatment, *Industrial wastes, Wastewater reuse, Membrane ultrafilter, Poultry industry.

A lab-scale membrane ultrafilter was constructed with one pair of tubular membranes, a circulation pump, and a storage tank. It was devised to treat the poultry processing wastewater in the laboratory and, simultaneously, to recover a by-product which was found to have nutritional value for its protein and fat contents. The wastewater collected from the poultry processing plant was circulating at 2.8 kg/cm2 (40 psi) and 57 liter/min (15 gal/min) around the membrane to perform an average membrane flux of 407 liter/day/m2 (10 gal/day/ft2). The original wastewater and the resulted permeate and concentrate were analyzed for chemical oxygen demand (COD), total solids (TS), nitrogen, fat and protein. The permeate, which contained only 240 mg/liter TS and 131 mg/liter COD, was believed to be safe for direct discharge or potential reuse. The by-product, which was generated from the drying of the concentrate, contained 30 to 35% of true protein and 24 to 45% of fat. The chemical score based on amino acid analysis was comparable to that of soybean protein. The results indicated that this new method may have great potential for application to the treatment of poultry processing wastewater. The by-product with its nutritional value could make it possible to generate an economic return for the processing industry to reclaim the operating cost and, perhaps, a part of the facility investment. (Kiger-North Carolina)
W80-05330

**PHOSPHORUS CONTROL STRATEGIES AT MUNICIPAL WASTEWATER TREATMENT PLANTS IN THE U.S. GREAT LAKES BASIN,**
Great Lakes Basin Commission, Ann Arbor, MI.
T. J. Monteith, R. A. Sullivan, and W. C. Sonzogni.
Great Lakes Environmental Planning Study, Contribution No 14, February 1980. 38 p, 12 Tab, 24 Ref.

Descriptors: *Phosphorus, *Sewage treatment, *Great Lakes, *Phosphorus removal, Detergent control, Great Lakes Environmental Planning Study, State phosphorus control programs, Point source inputs, Phosphorus loads, Municipal discharges.

Discharges from municipal wastewater treatment plants are the major source of total phosphorus (P) entering the Great Lakes. This report documents the current status of municipal P control programs in the Great Lakes basin. Thus, state policy on reducing P from municipal wastewater treatment plants within the Great Lakes basin and the present rate of compliance with this policy was examined. Information on the current technologies in use for controlling P at municipal wastewater treatment plants was also compiled. Finally, reductions in municipal P loads to surface water are presented. Each of the eight Great Lakes states has established P effluent limitations for sewage treatment plants. All plants discharging to Great Lakes surface waters, with a design flow of 1 million gallons per day (mgd) or greater, must limit the total P concentration in their effluent to 1 milligram per liter (mg/l). Most of the plants in the U.S. basin with P removal utilize a chemical precipitation process. Some use land application and others use tertiary advanced treatment processes, such as chemical treatment followed by special filtration. Five of the Great Lakes states currently limit P content to 0.5% by weight in home laundry detergents. Limiting P in these detergents is designed to reduce the amount of P entering municipal plants and reduce P discharges from combined sewer overflows.
W80-05336

**FEDERAL CONTROL OF WATER POLLUTION - AN OUNCE OF PREVENTION IS WORTH A POUND OF CURE,**
Levine and Krom, Beverly Hills.
For primary bibliographic entry see Field 6E.
W80-05374

## 5E. Ultimate Disposal Of Wastes

**LIMESTONE LINER FOR LANDFILL LEACHATES CONTAINING BERYLLIUM, CADMIUM, IRON, NICKEL, AND ZINC,**
Arizona Univ., Tucson. Dept. of Soils, Water, and Engineering.
J. Artiola, and W. H. Fuller.
Soil Science, Vol 129, No 3, p 167-179, March 1980. 6 Fig, 5 Tab, 33 Ref.

Descriptors: *Landfills, *Linings, *Limestones, *Leachate, *Heavy metals, Beryllium, Cadmium, Iron, Nickel, Zinc, Soil chemistry, Movement, Ion transport, Laboratory tests, Soils, Solid wastes,

Waste disposal, Adsorption, Ion exchange, Flue gas scrubbing.

The influence of crushed agricultural limestone, placed in a layer over six soils, on the rate of migration of beryllium, cadmium, iron, nickel, and zinc contained in municipal, solid-waste, landfill leachate, was evaluated. The limestone was highly effective in slowing the rate of migration of beryllium, cadmium, nickel, and zinc in all six soils, which represent five major soil orders of the United States. Not only breakthrough (C/C sub 0 = 0.5) but also final breakthrough (C/C sub 0 = 1) values were significantly delayed (twofold to threefold) over soil alone. The limestone effect was considerably more than additive, i.e., several times more than the sum of soil alone plus limestone alone. The limestone effects were not the same for the individual metals. Attenuation effects were greatest for beryllium and least for cadmium. The migration rate of iron, indigenous to the landfill leachate, also was favorably slowed by the limestone barrier layered over the soils. (Visocky-ISWS)
W80-05137

**HAWAIIAN WASTE INJECTION PRACTICES AND PROBLEMS,**
Hawaii Univ., Honolulu. Water Resources Research Center.
S. Petty, and F. L. Peterson.
Technical Report No 123, January 1979. 104 p, 3 Tab, 4 Fig.

Descriptors: *Waste disposal wells, *Injection wells, *Sewage effluents, Clogging, Suspended solids, Microorganisms, Hawaii, Construction, Evaluation, *Ghyben-Herzberg lens, Rehabilitation, Oahu, Maui, Kauai.

In recent years in Hawaii numerous shallow waste injection wells, constructed for the disposal of domestic sewage effluent, have failed to operate as designed. A field reconnaissance of all the known waste injection wells on Oahu and Kauai, and approximately half of those on Maui, was made and their methods of operation and injection problems evaluated. The results of this study indicate that injection well problems are primarily due to physical and biological, and probably to a much lesser extent, chemical clogging phenomena at the well face. The clogging in a large part results from improper treatment plant operation, improper injection well operation and maintenance, and poor well site selection. Improper well construction practices also contribute to a much lesser degree. Furthermore, the results of this study indicate that inadequate data collection, both prior to and after injection has begun, makes early detection and solution of the injection problems more difficult. Recommendations for more adequate data collection and treatment plant and injection well operation and maintenance are made which hopefully will avoid or at least alleviate many of the injection well problems encountered in this study.
W80-05157

**THE SILURIAN SALT DEPOSITS IN EASTERN LAKE, NORTHWESTERN ASHTABULA, AND NORTHEASTERN GEAUGA COUNTIES, OHIO,**
Geological Survey, Columbus, OH. Water Resources Div.
S. E. Norris.
Geological Survey open-file report 79-269, December 1978. 15 p, 8 Fig, 2 Tab, 2 Ref.

Descriptors: *Salts, *Ohio, *Aggregates, *Sedimentary rocks, *Carbonate rocks, Inorganic compounds, Sites, Drilling, Test wells, Subsurface investigations, *Radioactive waste disposal, *Silurian salt deposits, *Northeast Ohio.

Five salt zones, comprising single or multiple salt beds interbedded with dolomite, dolomitic shale and anhydrite, occur in a 250-square-mile area in eastern Lake, northwestern Ashtabula, and northeastern Geauga Counties, Ohio. The aggregate thickness of salt-bearing rocks, from the base of the lowest salt to the top of the highest salt, ranges from about 300 feet in the northern part of the area to more than 450 feet in the southern part. The aggregate thickness of salt, exclusive of the intervening rocks, also increases southward, from about 100 feet to more than 200 feet. The thickest salt bed, the F1A salt, is 35 to 38 feet thick in northeastern Geauga and southeastern Lake Counties. (Kosco-USGS)
W80-05295

## 5G. Water Quality Control

**WATER QUALITY TRAP EFFICIENCY OF STORM WATER MANAGEMENT BASINS,**
Maryland Univ., College Park. Dept. of Civil Engineering.
R. H. McCuen.
Water Resources Bulletin, Vol 16, No 1, p 15-21, February 1980. 4 Fig, 7 Tab, 11 Ref.

Descriptors: *Detention reservoirs, *Water quality, *Urban runoff, *Water quality control, Water pollution, Water pollution sources, Water pollution control, Sediments, Chemicals, Pollutants, Urban hydrology, Storm runoff, Storage, Water management(Applied), On-Site investigations, Data collections, Biochemical oxygen demand, Chemical oxygen demand, Metals, Nutrients.

While the quality of rivers has received much attention, the degradation of small streams in upland areas of watersheds has only recently been recognized as a major problem. A major cause of the problem is increases in nonpoint source pollution that accompany urban expansion. A case study was used to examine the potential for storm water detention as a means of controlling water quality in streams of small watersheds. The storm water management basin, which is frequently used to control increases in discharge rates, can also be used to reduce the level of pollutants in inflow to receiving streams. Data collected on a 148-acre site in Maryland showed that a detention basin can trap as much as 98% of the pollutant in the inflow. For the 11 water quality parameters, most showed reductions of at least 60%, depending on storm characteristics. (Sims-ISWS)
W80-05139

**INVESTIGATIONS OF SPARGING AS A METHOD FOR PROMOTING COOLING POND HEAT TRANSFER,**
Argonne National Lab., IL. Atmospheric Physics Section.
For primary bibliographic entry see Field 2H.
W80-05152

**AN EVALUATION OF ILLINOIS LAWS AND REGULATIONS RELATED TO THE QUALITY OF GROUND WATER.**
Illinois Univ. at Urbana-Champaign.
For primary bibliographic entry see Field 6E.
W80-05154

**OPTIMUM ALTERNATIVES FOR CONTROLLING COMBINED SEWAGE OVERFLOWS--A CASE STUDY,**
Barr Engineering Co., Minneapolis, MN.
For primary bibliographic entry see Field 6B.
W80-05170

**ON THE SCALING OF LABORATORY OXYGENATION STUDIES,**
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Wasserbau III.
M. Markofsky.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 801-810, 1978. 7 Fig, 7 Ref.

Descriptors: *Model studies, *Oxygenation, *Water quality control, *Reaeration, Hydraulic models, Dissolved oxygen, Reviews, Laboratory tests, Weirs, Data collections, Diffusion, Methodology, Open channel flow, Bubble curtains, Diffusers.

Literature and laboratory studies on artificial aeration were undertaken. The work was divided into three phases: (1) A literature study of weir aeration: This was undertaken because the large amount of laboratory and field data available in the literature enables, through dimensional analysis, a detailed investigation of model-prototype behavior to be made. (2) Experimental studies of diffused air aeration in flowing water using two-dimensional bubble curtains: In these studies systematic variations were made of the primary variables affecting aeration efficiency per unit depth, i.e., air flow rate per unit width, ambient water velocity, and type of diffuser. The laboratory results were compared with published laboratory and field data. (3) Experimental studies of diffused air aeration in stagnant water-model family: In three different diameter pipes in which water depths of up to 2.1 m could be obtained, the effect of model dimensions on aeration efficiency using single port diffusers was investigated. In these experiments the air flow rate, water depth, pipe diameter, and air port diameter were systematically varied. The ability to scale from smaller to larger pipe diameters was investigated thus yielding insight into model-prototype behavior. A nomogram was presented for the prediction of oxygen transfer as a function of the weir nappe Froude and Reynold's numbers. (See also W80-05159) (Humphreys-ISWS)
W80-05236

**IRRIGATOR INVOLVEMENT IN THE IMPLEMENTATION OF AGRICULTURAL NONPOINT SOURCE POLLUTION CONTROL PROGRAMS,**
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
R. G. Evans, W. R. Walker, and G. V. Skogerboe.
Water Resources Bulletin, Vol 16, No 1, p 133-136, February 1980. 1 Fig, 1 Tab, 8 Ref. EPA R-804672.

Descriptors: *Irrigation, *Water pollution control, *On-site investigations, *Colorado, Salinity, Salts, Water pollution, Water pollution sources, Pollutants, Farm management, Irrigation practices, Water management(Applied), Water users, Agriculture, Nonpoint water pollution sources.

Recently, Congress designated irrigated agriculture under the 'nonpoint source' category covered by Section 208 of P.L. 92-500 and involves the use of 'best management practices.' Generally, the most appropriate solutions for pollution abatement from irrigated agriculture involve the delivery and use of water rather than the treatment of irrigation return flows: (1) Technological alternatives should be utilized that are sensitive to local conditions and acceptable to the farmers. (2) Informational and educational programs to assist farm operators individually and collectively must be instituted prior to the start of the project; imaginatively conceived, and continuously modified and upgraded if motivation for change is to be encouraged. (3) Technical assistance personnel should be given short courses in skills needed for working effectively with irrigators. (4) Communication techniques used for working with farmers as individuals and groups should be designed into the implementation program and evaluated. (5) Credibility and trustworthiness of federal and state agencies in the eyes of the irrigators provide the important final ingredient in effectively implementing change and reducing nonpoint source pollution from irrigated agriculture. (Sims-ISWS)
W80-05257

**EPA SETS RULES ON HAZARDOUS WASTES,**
R. J. Smith.
Science, Vol. 207, No. 4436, p 1188, March 14, 1980.

Descriptors: *Waste disposal, *Regulations, *Hazardous wastes, Waste treatment, Water pollution treatment, Waste storage, Costs, Repairing, Environmental Protection Agency.

The EPA has published final rules requiring that generators, transporters, and disposers of hazardous wastes maintain records detailing exactly where the wastes are going. The cost of the resul-

tant paperwork is expected to be between $16 and $24 million annually. The EPA will also designate specific hazardous wastes and establish waste treatment, storage and disposal standards. The total cost of implementing these regulations has been estimated at about $1 billion annually. The cost of repairing damage done by improper disposal is estimated at 444 billion. Neither the states nor the federal government can afford the repair cost and numerous owners of substandard waste sites have threatened to walk away from their properly if the new regulations cost too much. The EPA is proposing a cleanup 'super-fund' which will draw its revenues from an annual contribution of 4700 million from the chemical industry. The fund will be used to clean up waste sites where a responsible party cannot be determined. (Purdin-NWWA)
W80-05322

# 6. WATER RESOURCES PLANNING

## 6A. Techniques Of Planning

**APPLICATIONS AND EVALUATION OF DECISION ANALYSIS IN WATER RESOURCES PLANNING,**
Decision Science Consortium, Inc., Falls Church, VA.
D. A. Seaver, R. V. Brown, V. N. Campbell, J. W. Ulvila, and J. O. Chinnis, Jr.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-185481, Price codes: A04 in paper copy, A01 in microfiche. Technical Report 79-2, Prepared for Office of Water Research and Technology, December 1979. 67 p, 35 Ref, Append. OWRT C-80054-P (No 8406)(1).

Descriptors: *Planning, *Decision making, *Decision analysis, Cost-benefit analysis, Water supply development, Evaluation, Water resources development, Computer models.

Decision analysis is a systematic way of structuring the considerations that enter into a planning or decision making problem. It facilitates the planning or decision making process primarily by enabling attention to be directed selectively at different components in a complex problem, and by properly integrating the various components. As such, decision analysis may offer a comprehensive, consistent framework for water resources planning that fills some existing methodological and practical gaps in current planning approaches. The work reported here was undertaken to explore the applicability of decision analysis to water resources planning. Our approach was to use decision analysis in two ongoing problems, working closely with the responsible planning authorities in each case. These applications, and an evaluation of the usefulness of decision analysis, are reported here. We also have provided some additional description of the general techniques and uses of decision analysis that potentially may be particularly appropriate for water resources planning. Our work indicates that decision analysis generally is seen as appropriate and useful by planners, and does offer some technical improvements for planning. However, many organizational and institutional constraints must be overcome to expand the actual use of decision analysis. Some suggestions are made as to how institutional acceptance may be gained.
W80-05104

**WATER-MANAGEMENT PLANNING FOR ILLINOIS COMMUNITIES,**
Illinois Univ. at Urbana-Champaign. Water Resources Center.
For primary bibliographic entry see Field 6B.
W80-05115

**COMPUTATIONALLY EFFICIENT POLYNOMIAL APPROXIMATIONS USED TO PROGRAM THE THEIS EQUATION,**
Wyoming Univ., Laramie. Dept. of Geology; and Wyoming Univ., Laramie. Water Resources Research Inst.
P. W. Huntoon.
Ground Water, Vol 18, No 2, p 134-136, March-April 1980. 7 Ref.

Descriptors: *Theis equation, *Aquifers, *Drawdown, *Recharge, *Model studies, Mathematical models, Computer models, Groundwater, Storage, Transmissivity, Pumping, Mathematics, Equations, Hydraulics, Hydrology, Hand calculator programs.

Polynomial approximations were developed for the infinite series embodied in the Theis equation. These have the following advantages when programmed for use on computers or hand calculators: (1) they are easy to program; (2) they are computationally efficient; and (3) they eliminate round-off errors. (Sims-ISWS)
W80-05121

**PROGRAMMABLE HAND CALCULATOR PROGRAMS FOR PUMPING AND INJECTION WELLS: II--CONSTANT PUMPING (INJECTION) RATE, SINGLE FULLY PENETRATING WELL, SEMICONFINED AQUIFER,**
Missouri Univ. Rolla. Dept. of Geological Engineering.
D. L. Warner, and M. G. Yow.
Ground Water, Vol 18, No 2, p 126-133, March-April 1980. 3 Tab, 7 Ref, 2 Append. EPA R805039-01-1.

Descriptors: *Wells, *Pumping, *Injection wells, *Model studies, Mathematical models, Computer programs, Water wells, Oil wells, Aquifers, Pressure, Drawdown, Groundwater, Hydrology, Semiconfined aquifers, Hand calculator programs.

In a previous article, programmable calculator programs were given for the calculation of head or pressure changes resulting from the pumping of wells completely penetrating a fully confined aquifer. Aquifers are often only semiconfined. That is, they are confined by aquitards or leaky confining beds. Such aquifers are frequently referred to as leaky aquifers. In this article, programs were documented for the calculation of head or pressure change resulting from pumping from or injection into a semiconfined aquifer. The programs were for the Texas Instruments TI 59 card programmable calculator, and were given in water well and practical oilfield units. Listings of the programs were contained in the appendices. (Sims-ISWS)
W80-05122

**MODELS AND METHODOLOGIES IN MULTI-OBJECTIVE WATER RESOURCES PLANNING,**
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
D. M. Mades, and G. Tauxe.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-185952, Price codes: A05 in paper copy, A01 in microfiche. Water Resources Center, University of Illinois Research Report No 150, February 1980. 98 p. OWRT B-105-ILL(4), 14-34-0001-7154.

Descriptors: *Multiple objectives, *Planning, *Water resources, Optimization, River basins, Water quality, Reservoirs, Models, *Systems analysis, Linear programming, Dynamic programming, Non-linear programming, *Model studies, Evaluation, *Mathematical models.

The number of mathematical models used to represent complex water resource systems has grown with the advent of high-speed computers and the validation of empirical hydrologic and hydraulic relations. At the same time, algorithms for solving mathematical decision-making models have also experienced rapid growth and development in the field of operations research. More recently, the planner has been forced to consider multiple objectives, which often conflict, in designing water resource systems. This report discusses the application of multiple objective optimization algorithms to water resources related problems. A very intensive survey of previous research in this area is summarized under the areas of river basin planning, water-quality management and reservoir management. Multi-objective or vector-valued optimization algorithms are reviewed as an extension of the earlier single objective optimization algorithms. An extension of classical dynamic programming was formulated during this study. Multi-objective dynamic programming was applied to several planning problems to illustrate its useful potential. The algorithm was used to generate trade-off functions for hypothetical and case reservoir studies and a stream water quality problem. This report represents a general overview of existing multi-objective water resources planning models. The general strengths and weaknesses of the various multi-objective optimization algorithms are briefly discussed. This report is intended to illustrate the usefulness of mathematical modelling in water resources planning.
W80-05156

**A PLAN TO STUDY THE AQUIFER SYSTEM OF THE CENTRAL VALLEY OF CALIFORNIA,**
Geological Survey, Menlo Park, CA. Water Resources Div.
G. L. Bertoldi.
Available from: OFSS, Box 25425, Fed Ctr, Denver CO 80225. Price codes: $6.50 in paper copy, $3.50 in microfiche. Geological Survey open-file report 79-1480, October 1979. 48 p, 3 Fig.

Descriptors: *Model studies, *Aquifer systems, *California, *Groundwater, *Water levels, Alluvial aquifers, Pumping, Drawdown, Agriculture, Irrigation, Computer models, Projections, Water utilization, Water quality, Energy, Groundwater management, Water management(Applied), Evaluation, Central Valley(Calif).

Unconsolidated Quaternary alluvial deposits comprise a large complex aquifer system in the Central Valley of California. Millions of acre-feet of water is pumped from the system annually to support a large and expanding agribusiness industry. Since the 1950's, water levels have been steadily declining in many areas of the valley and concern has been expressed about the ability of the entire ground-water system to support agribusiness at current levels, not to mention its ability to function at projected expansion levels. At current levels of ground-water use, an estimated 1.5 to 2 million acre-feet is withdrawn from storage each year; that is, 1.5 to 2 million acre-feet of water is pumped annually in excess of annual replenishment. The U.S. Geological Survey has initiated a 4-year study to develop geologic, hydrologic, and hydraulic information and to establish a valleywide groundwater data base that will be used to build computer models of the ground-water flow system. Subsequently, these models may be used to evaluate the system response to various ground-water management alternatives. This report describes current problems, objectives of the study, and outlines the general work to be accomplished in the study area. A bibliography of about 600 references is included. (Kosco-USGS)
W80-05296

**A ONE-DIMENSIONAL, STEADY-STATE, DISSOLVED-OXYGEN MODEL AND WASTE-LOAD ASSIMILATION STUDY FOR SOUTH FORK WILDCAT CREEK, CLINTON COUNTY, INDIANA,**
Geological Survey, Indianapolis, IN. Water Resources Div.
C. G. Crawford, W. G. Wilber, and J. G. Peters.
Available from: OFSS, USGS, Box 25425, Fed Ctr, Denver CO 80225. Price codes: $9.25 in paper copy, $3.50 in microfiche. Geological Survey open-file report 79-1074, July 1979. 66 p, 23 Fig, 11 Tab, 59 Ref.

Descriptors: *Model studies, *Dissolved oxygen, *Waste assimilation capacity, *Water quality, *Indiana, Streams, Forecasting, Streamflow, Low flows, Effluents, Water pollution, Water quality standards, Waste water disposal, Waste water treatment, Reaeration, Mathematical models, Biochemical oxygen demand, Nitrification, Ammonia, Nitrates, Nutrients, *Clinton County(Ind), *South Fork Wildcat Creek(Ind).

The Indiana State Board of Health is developing a State water-quality management plan that includes

establishing limits for wastewater effluents discharged into Indiana streams. A digital model calibrated to conditions in South Fork Wildcat Creek was used to predict alternatives for future waste loadings that would be compatible with Indiana stream water-quality standards defined for two critical hydrologic conditions, summer and winter low flows. Natural streamflow during the 7-day, 10-year low flow is zero, so no benefit from dilution is provided. The Indiana State Board of Health's projected ammonia-nitrogen concentration for the Frankfort wastewater-treatment facility will violate the instream total ammonia-nitrogen standard of 2.5 mg/l and 4.0 mg/l during summer and winter low flows, respectively. The model indicates that nitrification and algal respiration were significant factors affecting the dissolved-oxygen dynamics of South Fork Wildcat Creek during two water-quality surveys. Stream water quality during the two water-quality surveys was degraded by the discharge of wastewater receiving only primary treatment. Benthic deposits resulting from this wastewater discharge seem to exert a considerable oxygen demand. The discharge of partially treated wastewater should be eliminated when a new wastewater-treatment facility becomes operational in mid-1979. Therefore, benthic-oxygen demand due to benthic deposits should become negligible at that time. (Kosco-USGS)
W80-05299

**CONTRIBUTION OF GROUNDWATER MODELING TO PLANNING,**
Geological Survey, Reston, VA. Water Resources Div.
J. E. Moore.
Journal of Hydrology, Vol 43, p 121-128, 1979. 1 Tab, 15 Ref.

Descriptors: *Groundwater, *Computer models, *Analog models, *Planning, Digital computers, Groundwater availability, Forecasting, Water quality, Water supply, *Water resources development, Conjunctive use, Surface-groundwater relationships.

The consideration of ground water in water-resource planning frequently has been neglected because many planners believed that ground water could not be adequately evaluated in terms of availability, quality, cost of development, or effect of development on the surface-water supply. The development of predictive ground-water models now provides the water planner with tools to evaluate these problems. Highly sophisticated digital models can be used in planning the development of ground water and the conjunctive use of ground and surface water. The models are powerful tools for predicting the response of groundwater systems to stresses. They can also clarify the cause and progress of past stress. With this development it is now possible to integrate the utilization of ground water into water-resource planning with a high degree of confidence. (Kosco-USGS)
W80-05300

**U.S. HEAVY METAL LOADINGS TO THE GREAT LAKES: ESTIMATES OF POINT AND NONPOINT CONTRIBUTIONS,**
Great Lakes Basin Commission, Ann Arbor, MI.
T. M. Heidtke, D. J. Scheflow, and W. C. Sonzogni.
Great Lakes Environmental Planning Study, Contribution No 12, January 1980. 35 p, 18 Tab, 19 Ref.

Descriptors: *Trace elements, *Sewage treatment, *Overland flow, *Great Lakes, Path of pollutants, *Heavy metals, *Municipal wastes, Copper, Zinc, Lead, Cadmium, Forecasting, Great Lakes Environmental Planning Study, Projected trace metal loadings, Municipal discharges, Point and nonpoint source inputs.

Estimates of current and future loadings of copper, zinc, lead and cadmium to the Great Lakes from municipal wastewater effluents and land drainage in the U.S. were generated using information provided by individual water quality management (208) plans, as well as other recent studies of point and nonpoint source pollution within the basin. Projections indicate that by the year 1990 the U.S. municipal point source contribution will likely decrease by 20-30% from mid-1970 levels as a result of phosphorus control measures. In the absence of additional programs to control land drainage in the U.S., the annual lake input of these metals from rural runoff should exhibit a slight decrease (less than 5%) over the next 20 years, whereas loadings attributable to urban runoff should increase up to 20% over the same period. Land drainage in the U.S. portion of the Great Lakes basin appears to contribute a much higher input of metals than do municipal wastewater treatment plants. Hypothetical programs to control nonpoint source phosphorus loads within the basin were compared on the basis of their ability to reduce metals loads. Results indicate that low cost, voluntary measures to control rural runoff are not likely to significantly reduce metals loadings to the lakes, while remedial measures to control urban runoff, although costly, offer the potential for significant reductions in annual inputs of lead, zinc, copper and cadmium.
W80-05335

## 6B. Evaluation Process

**THE ECONOMIC CONSEQUENCES OF IRRIGATING CORN ON FINE TEXTURED SOILS IN THE HUMID MIDWEST,**
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
R. L. Clouser, and W. L. Miller.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-185341, Price codes: A03 in paper copy, A01 in microfiche. Purdue University Water Resources Research Center Technical Report No 96, April 1980. 47 p, 15 Tab, 19 Ref, 1 Append. OWRT B-120-ILL(1).

Descriptors: *Irrigation, *Corn, *Economic feasibility, *Soil texture, Central United States, Irrigation practices, Supplemental irrigation, Farm ponds, Reservoirs, Wells, Humid areas, Irrigation systems, Soybeans, Farm management, Indiana, Illinois, Missouri.

Substantial research has been conducted on the economic profitability of irrigation on coarse textured soils in the humid Midwest. There has only been limited attention given to the irrigation of fine textured soils in the area. However, there is the potential for an economic response to irrigation on fine textured soils with a restricted zone for plant root development. A mathematical programming model of a micro farm unit was used in the study. The model maximizes net farm revenue by choosing production levels, subject to technical constraints between inputs and outputs, and an initial endowment of fixed resources. In addition to the basic model formulation, an investment model of alternative irrigation systems is incorporated. The model considers six alternative grain production activities including dryland corn, four alternative acreage levels of irrigated corn and soybeans. Irrigation application of six inches of water during July and August was an activity considered for irrigated cropland. The results indicated the average yield increase of corn of at least 40 bushels per acre per year or a discount rate of no more than 14 percent was necessary if an irrigation system was expected to provide a greater return than dryland corn production. (Wiersma-Ind)
W80-05102

**APPLICATIONS AND EVALUATION OF DECISION ANALYSIS IN WATER RESOURCES PLANNING,**
Decision Science Consortium, Inc., Falls Church, VA.
For primary bibliographic entry see Field 6A.
W80-05104

**AN APPRAISAL OF CULTURAL AND PALEONTOLOGICAL RESOURCES WITHIN SECTIONS 1 AND 2 OF THE PROPOSED MIRDAN CANAL PROJECT, GARFIELD AND VALLEY COUNTIES, NEBRASKA,**
Nebraska Univ., Lincoln. Dept. of Anthropology.
N. S. King, and R. E. Pepperl.
Technical Report No 80-03, March 1980. Vol 1, 65 p, 1 Fig, 4 Tab, 74 Ref, 2 Append.

Descriptors: *Nebraska, *Archaeology, *Dating, *Surveys, Evaluation, History, Geologic history, Land use, Irrigation programs, Canal construction, Engineering, Inspection, Value.

Thirty-one locations of contemporary and early twentieth century material were identified in a cultural resources evaluation within sections 1 and 2 of the proposed Mirdan Canal project. The Mirdan Canal, designed to carry water from the Calmus Reservoir to the Davis Creek Reservoir, is part of a multi-purpose irrigation development within the North Loup Division, Nebraska. Steps involved in the survey included: (1) a records search, (2) a literature search, (3) National Register consultation, (4) paleontological records search and consultation, (5) county court records search, (6) field investigations, and (7) laboratory preparation and analysis of collected materials. Two separate field investigations were conducted, a reconnaissance level investigation of a one-acre seepage test and an intensive (100%) pedestrian survey of the entire area. In both surveys all accessible surface areas were systematically inspected and either zig-zag or straight line traverses were used depending on terrain and visibility. Some acreage was inaccessable but nearly 95% was completely surveyed. No paleontological or prehistoric Native American sites were located. In addition to the 31 contemporary and early twentieth century locations, 4 abandoned habitation sites and 23 isolated locations of discarded debris and dump areas were identified. Based on these results further investigations prior to construction are not recommended, however, construction crews should be made aware of the potential for encountering buried cultural resources. (Seigler-IPA)
W80-05109

**FINAL REPORT ON SAMPLING AND EVALUATION OF ARCHAEOLOGICAL AND HISTORICAL SITES IN OR NEAR BUREAU OF RECLAMATION'S AUTHORIZED SALMON FALLS DIVISION, TWIN FALLS AND CASSIA COUNTRIES, IDAHO,**
Idaho Museum of Natural History, Pocatello.
B. R. Butler, and P. R. Waite.
Archaeological Reports No 17, November 1978. 92 p, 42 Fig, 28 Tab, 15 Ref. 14-06-100-9135.

Descriptors: *Evaluation, *Archaeology, *Dating, *History, *Idaho, Human population, Land use, Surveys, Equipment, *Irrigation canals, Irrigation engineering, Irrigation programs, Diversion structures, Baseline studies.

Three seasons of archaeological survey and evaluation at the site of the proposed Salmon Falls Division irrigation project in Idaho identified eight aboriginal and four historical sites that may be damaged by the project. The project will involve the construction of a canal system running southwestward from the Milner Dam on the Snake River. The project will provide water to approximately 15,000 acres that are now dry. Only limited knowledge of the native people, the Shoshoni, is available. The eight aboriginal sites were all located within a 4 x 13 mile area across the northern end of the South Hills. These sites were evaluated by excavating a 1 m x 2 m pit in every 400 sq m sampling stratum mapped for each site. Data provided for each site include number of pits, number of cataloged artifacts, and number of waste flakes. At the sites lithic chipping debris strongly represents tool manufacturing and repair. From projectile point analysis two sites on Rock Creek were dated from the Early Archaic (5,800 B.C.-2,500 B.C.), while the other sites generally dated from the Middle Archaic (2,500 B.C.-A.D. 1,200-1,300). The four historical sites were evaluated by surface study only. Two of the historical sites are believed to be part of the many lateral tracks from the Oregon Trail. A third historical site was composed of broken glass along the bank of the irrigation canal and the fourth was the foundation of a turn of the century barn. While none of the sites are likely to yield much new information, disturbance of the sites should be avoided when possible. (Seigler-IPA)

W80-05113

**WATER-MANAGEMENT PLANNING FOR ILLINOIS COMMUNITIES,**
Illinois Univ. at Urbana-Champaign. Water Resources Center.
A. Weeks.
Report No UILU-WRC-79-0009, Special Report 9, July 1979. 97 p, 1 Fig, 6 Tab, 31 Ref. OSS 77-21209.

Descriptors: *Illinois, *Administration, *Water management(Applied), *Water utilization, Project planning, Soil erosion, Sedimentation, Water supply, Water rates, Water wells, Water resources development, Water policy, Land use, Economic feasibility.

Ten documents on water management and planning prepared as part of a series of community education programs in Illinois are presented as background material for community citizens and officials to provide a common denominator of knowledge. The documents presented are: (1) Introduction to Water-Management Planning, (2) Water Conservation, (3) Water Availability: Present Adequacy and Future Alternatives, (4) Water Quality and the Water System, (5) Management, Planning, and Maintenance of Municipally Owned Water Systems, (6) Economic Concerns and Financing of Water Systems, (7) Private Home Water Systems, (8) Areawide Options, (9) Soil Erosion, and (10) The Role of Water and Reservoirs in Economic Growth. Technical terms are avoided when possible and some costs are provided as a basis for comparisons. Five main aspects are involved in water-management planning: the quantity of water naturally available; the quality of available water; the adequacy, reliability, and maintenance of the water system; waste water treatment and reuse; and community needs and resources. Also, land use planning and water management must go together. Included at the end of each document is a list of questions to help a community find specifics about its own situation along with possible sources for answers. (Seigler-IPA)
W80-05115

**OPTIMUM ALTERNATIVES FOR CONTROLLING COMBINED SEWAGE OVERFLOWS--A CASE STUDY,**
Barr Engineering Co., Minneapolis, MN.
I. Yomtovian.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 129-146, 1978. 5 Fig, 2 Tab, 6 Ref. EPA C270831-2.

Descriptors: *Decision making, *Combined sewers, *Urban runoff, *Alternate planning, Overflow, Planning, Conveyance structures, Urban hydrology, Separated sewers, Bypasses, Water quality, Water pollution sources, Economics, Costs, Methodology, Analytical techniques, Dissolved oxygen, *Red Wing(MN), Case study, Sanitary sewage overflow.

The major concern of this study is the control and treatment of sanitary sewage overflows from the combined sewer systems located in Red Wing, Minnesota. Frequent high quantity untreated sanitary flows entering the Mississippi River (MR) at Red Wing are degrading the water quality of the river. The high rate of sanitary sewage overflow into the river is primarily due to the existence of the inadequate and poorly located sanitary sewer interceptors. The untreated sanitary sewage flow by-passes the existing treatment plant under the following three distinct conditions: (1) when the MR water elevation exceeds the invert elevation of the combined sewer systems; (2) when dry weather sanitary flows exceed the maximum intake capacity of the regulators; and (3) when the combined sanitary and storm runoff exceeds the maximum intake capacity of the regulators and the available storage capacity of the combined sewers. The optimum waste control measure is the combination of the most cost-effective alternatives which provide the most acceptable (desirable) waste control level. To facilitate the process of decision making in the selection of optimum alternatives, the following schemes were suggested: select the most cost-effective combination of alternatives based on the available budget, an acceptable percentage of waste control, and/or based on the waste control costs ($/MGY) spent in other cities comparable to Red Wing. (See also W80-05159) (Humphreys-ISWS)
W80-05170

**EFFECTS OF RURAL WATER SYSTEMS ON LOCAL GOVERNMENT REVENUES AND EXPENDITURES IN SELECTED COUNTIES OF SOUTH DAKOTA,**
South Dakota State Univ., Brookings. Dept. of Economics.
A. A. Lundeen, and L. L. Janssen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-188055, Price codes: A10 in paper copy, A01 in microfiche. South Dakota Water Resources Institute, South Dakota State University Completion Report 1979. 219 p, 2 Fig, 48 Tab, 25 Ref, 10 Append. OWRT B-056-SDAK(1), 14-34-0001-8118.

Descriptors: *Rural areas, *South Dakota, *Water distribution(Applied), *Government finance, Taxes, Economic analysis, Regression analysis, Surveys, Statistical methods, Population, Income analysis, Education, Mathematical models, Water systems.

Surveys and statistical analyses were used to evaluate the impact of the Brookings-Deuel Rural Water System on the revenues and expenditures of local governments in the area. Two mail surveys were used to gather demographic data and housing characteristics for the population and its subgroups in the area served by the water system. Chi-square, analysis of variance, and multiple regression tests were used to determine if significant differences existed. Personal interviews were conducted to gather information on housing, farming operations, consumer purchases, satisfaction with the water system, and perceptions of changes by the owners in their property value due to the water system. County officials, school district officials, realtors, and appraisers were also interviewed. Using the data collected a previously developed model was modified to simulate the effects of the rural water system on the public sector. The model can be used to estimate a range of impacts. Results show that farm or nonfarm employment and income orientation are related to system membership, rural user families are younger than nonuser families, users have higher income levels than nonusers, education levels of adults is not related to system use, and users have one or more children than nonusers. Approximately 40% of those surveyed felt that the water system increased the value of their land. Net positive gains were found for all but one unit of government. Gains in total property tax revenues from the increase in property value are not occurring and may not occur unless new assessments of property for tax purposes reflect this increase in value. (Seigler-IPA)
W80-05242

**A DYNAMIC REGIONAL IMPACT ANALYSIS OF FEDERAL EXPENDITURES OF A WATER AND RELATED LAND RESOURCE PROJECT -- THE BOISE PROJECT OF IDAHO, PART II: SECONDARY ECONOMIC IMPACTS OF THE BOISE PROJECT OF IDAHO, 1947-1970,**
Idaho Univ., Moscow. Dept. of Agricultural Economics.
R. B. Long, and C. J. Potratz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-191430, Price codes: A07 in paper copy, A01 in microfiche. Idaho Water Resources Research Institute, University of Idaho. Research Technical Completion Report, March 1979. Volume II of V. 118 p, 21 Fig, 6 Tab, 19 Ref, 7 Append. OWRT C-6276 (No 5226)(3).

Descriptors: *Idaho, *Economic impact, *Input-output analysis, *Irrigation systems, Economics, Mathematical studies, Food processing industry, Industries, Cost-benefit ratio, Cost repayment, Econometrics, Benefits, Annual costs, Financial analysis, Monetary benefits, Boise Project.

Secondary or induced economic impacts resulting from the Boise Project, an irrigation and power project in southwestern Idaho, are analyzed. The Project was built by the Bureau of Reclamation between 1910 and 1956 and is now managed for irrigation, power, recreation, and flood control. The Project has produced a thriving irrigated agricultural production area of approximately 340,000 acres as of 1970. This agricultural production in turn has resulted in the growth of supplying (input) industries and agricultural (output) processing industries. An aggregate economic input-output model is used to simulate the impact of the Boise Project on the Idaho economy. Results indicate that direct income impacts increased from $17.9 million in 1947 to $28.1 million in 1970. For the same time period indirect or secondary impacts increased from $45.9 million to $99.1 million. Since 1947 the total impact of the project on regional income has dropped from 41.4% to 22.1% which shows that the region is expanding more rapidly than the Project. The Project has had a major influence on the development and growth of the area's food processing industry. In 1970 the food processing industry's economic impact ($143.7 million) was greater than the Project's economic impact ($127.2 million). Also as of 1970, annual project impact both direct ($28.1 million) and indirect ($99.1 million) more than repay the annual Project costs of $5.5 million. (Seigler-IPA)
W80-05243

**SECOND HOMES IN NORTH CAROLINA: AN ANALYSIS OF WATER RESOURCE AND OTHER CONSEQUENCES OF RECREATIONAL LAND DEVELOPMENT,**
North Carolina Univ. at Chapel Hill. Center for Urban and Regional Studies.
R. J. Burby.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-190648, Price codes: A12 in paper copy, A01 in microfiche. Water Resources Research Institute of the University of North Carolina, Raleigh. Report No UNC-WRRI-79-150, December 1979. 278 p, 43 Tab, 137 Ref, 4 Append. OWRT A-092-NC(3).

Descriptors: *Land use, *North Carolina, *Recreation facilities, *Land development, Environmental effects, Recreational demand, Cost-Benefit analysis, Economics, Erosion, Septic tanks, Mountains, Coasts, Land management, Land resources, Recreation.

The environmental impact of recreational land development was studied in 18 mountain and 20 coastal counties in North Carolina. North Carolina has experienced a boom in second homes and recreational land development; however, 40% of this development is concentrated in only 5 of the 38 counties studied. Three sources of data were used for the study: (1) secondary data from the Office of Interstate Land Sales Registration; (2) original data from mail questionnaires returned by 71 development firms in the state; and (3) original data from two waves of personal interviews with a sample of 227 local officials. Environmental, social, fiscal, and economic consequences of development were identified. Local public officials of the developed areas overwhelmingly believe that development has been beneficial to their counties due to positive economic consequences. A conceptual model was developed to explain how the objective characteristics of the environmental impacts are associated with officials' perceptions of those atributes. Problems associated with development include septic tank failures, pollution, erosion, roadside litter, inadequate access, traffic congestion, and flooding. Adverse economic effects include steeply escalating land prices and increased demand for public services. Both coast and mountain officials feel that existing local and state institutions could do more to promote improved land development practices. Increased citizen awareness would also be a positive step. (Seigler-IPA)
W80-05248

**LAKE SUPERIOR IN THE 21ST CENTURY,**

Canada Centre for Inland Waters, Burlington (Ontario).
H. Shear.
Journal of Great Lakes Research, Vol 4, No 3-4, p 550-553, December 1978. 3 Tab, 7 Ref.

Descriptors: *Lake Superior, *Projections, *Population, *Economics, Land use, Phosphorus, Waste disposal, Water pollution sources, Fisheries, Agriculture, Industries, Mining, Forestry, Twenty-first century.

Projections of population, industrial growth, phosphorus inputs, changes in land use patterns and waste disposal are given. Phosphorus loadings to Lake Superior from point sources are projected to increase only slightly by the year 2020, assuming all large sewage treatment plants meet a 1 mg/l effluent limitation. Increases in industrial and mining activities could have significant negative impacts on the lake, but these impacts have not been quantified. The Great Lakes community has adopted a philosophy of no further degradation of Lake Superior. In order to achieve this, more efficient and innovative methods will have to be employed to ensure that pollutants do not enter the lake from industrial discharges, municipal sewage treatment plants, urban runoff, and runoff from waste disposal sites. (Humphreys-ISWS)
W80-05265

## 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

**FRANCE: WHERE THE METER IS 'UNIVERSAL',**
L. Freeman.
Water, No 31, p 43-44, March 1980. 4 Fig.

Descriptors: *France, *Water supply, *Water costs, *Water rates, Water distribution(Applied), Potable water, Water purification, Ozone, Potable water, Environmental sanitation, Sewage disposal, Taxes, Costs, Water meters.

The French water industry continues to move forward with services, billing, and the supplying of potable water. The industry has used meters since its establishment in the early 19th century. The industry also provides all the sanitation services. Not only does the consumer pay for water and sanitation services, he also pays several taxes such as a value added tax (VAT) of 7%, a tax to subsidize services to rural communities, and local taxes. Approximately 40% of a customers bill is for water supplied while 60% goes for taxes. These taxes have approximately doubled the customer's cost in the last few decades. The average annual bill for a family of four is about 800 Francs. France has five major water companies that supply a total of 1,500 million cubic meters a year. The oldest company, Compagnie Generale des Eaux, provides approximately 5 million cubic meters daily. All the French water companies use ozone rather than chlorine for purification. A large ozonization plant at Choisy-le-Roi near Paris produces 800,000 cubic meters daily. Despite the current use of a metering system, the industry does have problems with reading them. Future developments include the use of remote reading using computers and cable television linkups. (Seigler-IPA)
W80-05118

## 6D. Water Demand

**REPORT OF THE RIVER MASTER OF THE DELAWARE RIVER FOR THE PERIOD DECEMBER 1, 1977 -- NOVEMBER 30, 1978,**
Geological Survey, Reston, VA. Water Resources Div.
F. T. Schaefer, and R. E. Fish.
Geological Survey Delaware River Master report, 1979. 94 p, 6 Fig, 1 Plate, 20 Tab.

Descriptors: *Delaware River, *Watershed management, *Available water, *Water delivery, *Water quality, Reservoir storage, Reservoir releases, Estuaries, Saline water intrusion, Monitoring, *Delaware River Master, Annual report.

This annual report of the River Master of the Delaware River is for the year December 1, 1977, to November 30, 1978. In terms of water supply, the year was above normal. The discharge of the Delaware River at Montague, New Jersey, adjusted for diversions and changes in reservoir storage, was 14 percent above median. Total combined storage in Pepacton, Cannonsville, and Neversink Reservoirs was 98.0 percent of capacity on December 1, 1977, as compared with 87.9 percent a year earlier. This was the highest total storage at the beginning of any report year since the construction of the reservoirs. Diversions for water supply for New York City and releases to maintain the flow of the Delaware River at Montague were made under the supervision of the River Master, as provided in the terms of the Amended Decree of the Supreme Court, June 7, 1954. Diversions through the Delaware & Raritan Canal in New Jersey did not exceed the limits imposed in Section V of the Decree. Data from the Water-quality monitoring program carried out by the U.S. Geological Survey in the Delaware River Estuary are included. (Kosco-USGS)
W80-05292

**AVAILABILITY OF SUPPLEMENTAL WATER SUPPLIES AT SALMONID FISH-PROPAGATION STATIONS IN WISCONSIN,**
Geological Survey, Madison, WI. Water Resources Div.
C. A. Harr, and R. P. Novitzki.
Available from: OFSS, Box 25425, Fed Ctr, Denver CO 80225. Price codes: $2.00 in paper copy, $4.00 in microfiche. Geological Survey open-file report 79-1170, October 1979. 13 p, 5 Fig, 4 Tab, 3 Ref.

Descriptors: *Groundwater availability, *Surface water availability, *Water supply, *Fish hatcheries, Streamflow, Flow characteristics, Diversion, Impoundments, Aquifers, Wells, Water yield, Pumping, Estimating, Digital computers, Drawdown, Water quality, Wisconsin, *Salmonid fish-propagation stations, Supplemental water supplies.

Supplemental water supplies are available at all the 12 fish-propagation stations. At seven of the stations water may be obtained by diverting or impounding streams. Ground water is available from glacial sand-and-gravel aquifers at all the stations and from sandstone aquifers at 7 of the 12 stations. Probable well yields range from 100 to 1,000 gallons per minute from the sand and gravel and from 50 to 1,000 gallons per minute from the sandstone. The response of pumping 1,600 gallons per minute from a ground-water source at Crystal Springs, Langlade, Nevin, and Osceola was estimated by a digital model. Estimated drawdown after 10 years of pumping ranged from 10 to 28 feet (6 to 35 percent of the saturated thickness of the aquifers). (Kosco-USGS)
W80-05304

**MANAGING A LIMITED RESOURCE: THE POLITICAL CONSTRAINTS ON WATER POLICY IN THE FOUR-CORNERS STATES,**
Arizona Univ., Tucson.
For primary bibliographic entry see Field 6E.
W80-05370

**COMMENTS ON 'FEDERAL RESERVED WATER RIGHTS',**
Debevoise and Liberman, Washington, DC.
For primary bibliographic entry see Field 6E.
W80-05375

## 6E. Water Law and Institutions

**AN EVALUATION OF ILLINOIS LAWS AND REGULATIONS RELATED TO THE QUALITY OF GROUND WATER.**
Illinois Univ. at Urbana-Champaign.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-183528, Price codes: A06 in paper copy, A01 in microfiche. Report, June 1979. 110 p, 2 Tab.

Descriptors: *Illinois, *Reviews, *Groundwater, *Legislation, *Water law, Water pollution control, Water quality, Legal review, Regulation, Administration, Water utilization, Water policy, Water pollution sources, Water quality standards, Institutions, Water permits, Permits, Waste water disposal, Waste disposal wells, Waste disposal.

This study contains an analysis of existing Illinois statutes, administrative regulations, and policies and practices affecting the quality of groundwater, together with recommendations for changes needed to establish a comprehensive groundwater protection program for the state. Some principal tasks of the research were to: (1) identify regulatory deficiencies, gaps, and overlaps, (2) examine federal laws, regulations, and court decisions to determine requirements applicable to state control of groundwater pollution, and (3) recommend modifications of Illinois statutes, regulations, policies, and implementation practices to achieve a comprehensive and effective program. The following eight proposals were made: (1) adopt a policy to protect groundwater quality, (2) designate an agency with primary responsibility for groundwater quality, (3) develop a groundwater data base, (4) develop a groundwater quality monitoring program, (5) establish groundwater quality standards, (6) regulate water use to control groundwater quality, (7) control surface water quality, and (8) develop specific standards, permits, and management practices for specific activities causing groundwater pollution. Recommendations were also made for control of specific pollution sources, with priority rankings, for the form of the proposed control, e.g., legislation, regulation, or administrative practice, and for the identity of agencies whose authority would be exercised, increased, or decreased if the proposal were implemented. (Stout-Illinois)
W80-05154

**ASSESSING LAND USE CHANGES WITH AN URBAN RUNOFF MODEL,**
North Virginia Planning District Commission, Falls Church.
For primary bibliographic entry see Field 2A.
W80-05239

**COMPARISON OF STORMWATER DETENTION POLICIES,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W80-05241

**EPA SETS RULES ON HAZARDOUS WASTES,**
For primary bibliographic entry see Field 5G.
W80-05322

**TURN THIS WATER INTO GOLD THE STORY OF THE NEWLANDS PROJECT,**
Nevada Historical Society, Reno.
J. M. Townley.
1977, 160 p, Nevada Historical Society, Reno. OWRT A-074-NEV(4), 14-34-0001-7060.

Descriptors: *Irrigation districts, *History, *Federal reclamation law, *Nevada, Water resources development, Land resources, Irrigation systems, U.S. Bureau of Reclamation, *Truckee-Carson Irrigation District(NV), Churchill County(NV), Federal Reclamation Act of 1902.

This book is primarily a biography of the first federal reclamation district in the U.S. The Truckee-Carson Irrigation District is a cooperating organization composed of members, geographical areas, numerous dams, canals, reservoirs and electrical plants, farms, dairies, cattle feeding operations, residential communities and recreation-wildlife sanctuaries. The year 1976 marked the 50th anniversary of self-rule for this district. In 1926 the U.S. Bureau of Reclamation transferred control to the newly formed TCID (Truckee-Carson Irrigation District). The book, replete with photographs, traces the history of the area from the 1800's to 1976 and documents the many problems faced by the irrigation district since the National Reclamation Act of 1902. (Smith-Nevada)



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W80-05328

**RECLAMATION AND THE RED MAN: RELATIONSHIPS ON THE TRUCKEE-CARSON PROJECT, NEVADA,**
Nevada Historical Society, Reno.
J. M. Townley.
The Indian Historian, Vol 11, No 1, p 21-28, 1978.
OWRT A-074-NEV(3), 14-34-0001-7060.

Descriptors: *Paiute Indians, *Indian reservations, *Reclamation, *Irrigation, *Water rights, Legal aspects, Nevada, Truckee-Carson Irrigation District(NV), U.S. Reclamation Service.

This article traces the developing relationships among the U.S. Reclamation Service (USRS), formed in 1902 as a progressive measure, the white entryman, and the Indian during the period 1903 to 1926, at which time operational control of the federally funded reclamation project passed to the locally-directed TCID (Truckee-Carson Irrigation District), Nevada. The Indians of Lahontan Valley, as well as those around Pyramid Lake, were very much affected by the Truckee-Carson Project, and a series of court cases followed. Between 1903 and 1926 decisions imposed by USRS and Congress took about 30,000 acres from Paiute allottees in exchange for ten-acre plots within a reservation composed of only seven sections. The history of attempts to settle the Indians on the reservations and the conditions therein are described. (Smith-Nevada)
W80-05329

**PHOSPHORUS CONTROL STRATEGIES AT MUNICIPAL WASTEWATER TREATMENT PLANTS IN THE U.S. GREAT LAKES BASIN,**
Great Lakes Basin Commission, Ann Arbor, MI.
For primary bibliographic entry see Field 5D.
W80-05336

**THE URBAN COAST FROM A NATIONAL PERSPECTIVE,**
National Oceanic and Atmospheric Administration, Office of Coastal Zone Management.
A. B. Cowey.
Coastal Zone Management Journal, Vol 6, No 2/3, p 135-165, 1979. 2 Maps.

Descriptors: *Coasts, *Shore protection, *Public access, *Urbanization, Federal government, Environmental effects, Administrative agencies, Resources development, Legislation, Ecology, Management.

Nearly 40% of the United States population is concentrated in coastal urban centers whose populations exceed 500,000. The pressures for new housing, tourist, and recreational facilities, as well as environmental concerns, have contributed to intra-urban conflict over the direction and appropriate mix of waterfront uses. To date, no one federal agency or program has been specifically charged with overseeing the urban coastal resource as an entity, nor is it likely that one will. However, national concern for various aspects of the urban coastal issues has been expressed. In 1972, the Coastal Zone Management Act declared a national interest in the effective management, beneficial use, protection and development of the coastal zone. A national involvement can also be traced through a number of federal activities. These include the Urban Recreation Study, the Urban Waterfront Study, the Maritime Preservation Program, shorefront access and planning, and the implementation of State Coastal Zone programs. (Wilson-Florida)
W80-05363

**THE LOST WATERFRONT OF NEW YORK,**
New York Univ., NY. Graduate School of Public Administration.
M. L. Moss.
Coastal Zone Management Journal, Vol 6, No 2/3, p 167-185, 1979. 2 Tab.

Descriptors: *New York, *Shore protection, *Local governments, Urbanization, Water law, Land use, Programs, Administrative agencies, Public access, Planning, Management.

The New York City (NYC) waterfront differs dramatically from most urban coastal areas in the United States. In size its shoreline is far more extensive than any other city's. Municipal ownership of much of the waterfront gives the city direct control over the use of substantial portions of abutting land. No integrated policy exists for managing the NYC waterfront. Municipal government has done little to improve the shoreline. Citizens' groups and other organizations have made the greatest effort to improve the use of the city's coastal resources. NYC needs a well-defined policy for formulating and implementing programs in the coastal zone. An initial step for the city is to establish an accurate, reliable and up-to-date information system for the waterfront property it owns. Second, the city needs to develop a program for increasing public access to the waterfront. Third, more attention and assistance must be given to local groups. Finally, the city must press for an urban perspective in coastal management with external agencies. (Wilson-Florida)
W80-05364

**ENERGY FACILITY SITING IN THE URBAN COASTAL ZONE: COMPATIBLE OR NOT,**
Princeton Univ., NJ.
D. L. Morell.
Coastal Zone Management Journal, Vol 6, No 2-3, p 215-232, 1979. 2 Fig.

Descriptors: *Energy, *Facilities, *Coasts, *Shore protection, Water law, Environmental effects, Sites, Power operation and maintenance, Cooling water, Public access, Oil industry, Water pollution.

In recent years a rural/urban coastal dichotomy has emerged. This has been especially prominent in the siting of energy facilities since these operations are often water dependent. Power plants need huge amounts of cooling water. Offshore oil and gas extraction requires onshore support facilities. Recently, this issue has gaines special prominence on the East Coast with the commencement of offshore oil and gas exploration. A case study was conducted in Hudson County, New Jersey, in New York harbor, where five oil-related facility proposals were rejected from 1972 to 1976, primarily due to citizen opposition. Citizen activists now see the urban waterfront as a special place to which they want access. Amenity uses are preferred over a continuation of past, almost exclusive, industrial development. Citizen opposition is primarily concerned with pollution and safety. Innovative siting which utilizes inland, rather than coastal, locations is suggested as one way to lessen urban/rural siting controversy. (Wilson-Florida)
W80-05365

**COASTAL ZONE MANAGEMENT: THE FIRST FIVE YEARS AND BEYOND,**
National Oceanic and Atmospheric Administration, Washington, DC.
R. W. Knecht.
Coastal Zone Management Journal, Vol 6, No 4, p 259-272, 1979.

Descriptors: *Coasts, *Shore protection, *Federal government, State governments, Wetlands, Resources development, Public access, Inter-agency cooperation, Administrative agencies, Legislation, Environmental control, Management.

More than five years have passed since the Office of Coastal Zone Management issued the first coastal zone management (CZM) program development grants. Since then, all 35 coastal states and territories have participated in the program. By spring 1980, more than 75% of the country's shoreline will be covered by federally approved management plans. Any examination of the national CZM program involves consideration of the record at the state and local levels. Substantive results are expected in four major areas. First, and foremost, is protection of such natural resources as wetlands, beaches, dunes, and barrier islands. Second is the concern for more effective coastal development management. A Third area is increasing recreational access to the coast. Fourth is an emphasis on increasing intergovernmental cooperation and coordination. Today the emphasis of the CZM program is shifting from planning to implementation. A proposed amendment to section 303(b) of the Coastal Zone Management Act will clearly incorporate full consideration of national needs during the implementation of CZM programs. (Wilson-Florida)
W80-05366

**A PETROLEUM INDUSTRY PERSPECTIVE ON FEDERAL COASTAL ZONE MANAGEMENT,**
American Petroleum Inst., Washington, DC.
S. P. Chamberlain.
Coastal Zone Management Journal, Vol 6, No 4, p 281-294, 1979.

Descriptors: *Oil industry, *Federal government, *Land use, *Shore protection, Coasts, Programs, Administrative agencies, Legislation, State governments, Regulations, Environmental control, Energy.

Two of the most ambitious provisions of the Coastal Zone Management Act (CZMA) require consideration of national interests in facility siting and federal consistency with approved state programs. The petroleum industry is most concerned with the federal consistency requirement which allows state coastal management policies to assume the force of federal law by virtue of the National'Oceanic and Atmospheric Administration's (NOAA) approval of a state coastal zone management program. Moreover, the comples federal consistency procedures under CZMA are counter-productive to the expressed purpose of the Outer Continental Shelf Lands Act. The petroleum industry's secondary concern is NOAA's interpretive changes of the Act and its regulations which allow state programs approval based on inadequate state statutory and regulatory frameworks. This has occured where states give inadequate consideration to the national interest, unwilling to adopt stronger oversight control over local land-use decisions as required by the CZMA. Strong Congressional reaffirmation of CZMA's intent is needed to redirect NOAA's implementation of the Act. (Wilson-Florida)
W80-05367

**UNRESOLVED ISSUES OF COASTAL ZONE MANAGEMENT,**
Rose, Schmidt, Dixon, Hasley, Whyte and Hardesty, Washington, DC.
J. R. Spradley, Jr.
Coastal Zone Management Journal, Vol 6, No 4, p 303-310, 1979.

Descriptors: *Energy, *Shore protection, *Facilities, *Resources development, Coasts, Administrative agencies, Oil industry, Sites, Programs, Planning, Land use, Legislation.

The Coastal Zone Management Act (Act) has been subjected to conflicting claims of inadequacy, by both governmental agencies and private users of the coastal zone, such as the electric utility and petroleum industries. Electric energy facilities are of national and state interest but of regional and local benefit. Once the need for a facility has been determined, industry is concerned with management of environmental impacts from these facilities. Section 307 of the Act covers federal agency activities and development projects, requiring federal agency actions be consistent. Coastal interests have differing concerns regarding federal consistency. The most immediate impact of federal consistency on the electric utility industry is its application to existing facilities. Section 306(c) (8) of the Act requires that each state program give adequate consideration to national interests in planning and siting energy facilities. However, regulations of the National Oceanic and Atmospheric Administration discourages consideration of the national interest in energy facilities. Congressional clarification or amendment is necessary to limit application of federal consistency to new facilities and to properly balance coastal resources with the need for energy facilities. (Wilson-Florida)
W80-05368

**INDIAN RESERVED WATER RIGHTS: THE WINTERS OF OUR DISCONTENT.**
Yale Law Journal, Vol 88, No 8, p 1689-1712, July 1979.

Descriptors: *Water rights, *Indian reservations, *Reservation doctrine, Prior appropriation, Judicial decisions, Water users, Water shortage, Economic impact, Regional development, Resource allocation, Resources development.

Enormous Indian water claims will strikingly affect the economic futures of both the Indians and the western states. Unfortunately, legal uncertainty about Indian water rights impedes future western growth and threatens Indian aspirations for economic improvement. The Supreme Court in 1908 recognized an implied water right, independent of state law, associated with Indian reservations. Most Indian reserved rights have never been officially quantified. Indians are now demanding larger amounts of water than previously used, extending claims beyond available supplies and threatening the rights of current non-Indian water users. The legal uncertainty of Indian water rights impairs public water planning, distorts water investment decisions and handicaps negotiations important to Indian economic development. Possible avenues for defining the scope of Indian reserved rights - administrative, legislative, and judicial decision-making- are evaluated. As a first step in resolving the Indian water dilemma, the federal courts must define the scope of Indian reserved water rights. (Daniels-Florida)
W80-05369

**MANAGING A LIMITED RESOURCE: THE POLITICAL CONSTRAINTS ON WATER POLICY IN THE FOUR-CORNERS STATES,**
Arizona Univ., Tucson.
H. Ingram, N. Laney, and J. R. McCain.
Utah Law Review, Vol 1979, No 4, p 719-745, 1979. 17 Tab.

Descriptors: *Water allocation(Policy), *Political aspects, *Water policy, *Federal-state water rights conflicts, Surveys, Energy, Federal government, State governments, Reclamation, Water rights, Public rights, Federal project policy.

Westerners feel abundant water is the key to economic prosperity, and so important to the quality of life that it must be made available to everyone. Such views underlie the distributive water politics that have resulted in Congress' authorizing and funding of scores of large-scale reclamation projects through a process of log-rolling and mutual accomodation. If past practices of federal dominance in planning and financing of projects is to change, the role of state governments will be crucial. Data reveals that both voters and state legislators tend to favor future water allocation on the same basis as the present. Some differences between senators' and voters' opinions about water emerge. Legislators are more willing to change water allocations among users. However there is little constituency incentive for legislators to take positive action in water policy. If the direction of water politics is left to the residents of western states and their elected state representatives, there may be little change from past policy. (Wilson-Florida)
W80-05370

**COASTAL ENERGY IMPACT PROGRAM BOUNDARIES ON THE ATLANTIC COAST; A CASE STUDY OF THE LAW APPLICABLE TO LATERAL SEAWARD BOUNDARIES,**
D. R. Christie.
Virginia Journal of International Law, Vol 19, No 4, p 841-882, Summer 1979. 2 Fig.

Descriptors: *Boundaries(Property), *State jurisdiction, *Oceans, *Boundary disputes, State government, Federal government, International law, Law of the sea, Legal aspects, Legislation, Judicial decisions, Monetary benefits.

Interstate seaward boundaries are important in questions of conflicts of law and in allocation of funds under the Coastal Energy Impact Program (CEIP). If no state seaward boundary exists, a state's adjacent continental shelf acreage is determined according to applicable principles of law. These include specifically the Convention on the Territorial Sea and the Contiguous Zone and, generally, international law, United States (U.S.) statutory and case law, and conventions. International, national and the individual states legal positions concerning the extension of state boundaries are discussed with possible solutions to the boundary dilemma included. Inconsistencies might arise between boundary delimitations for CEIP allocations and for state law under the Outer Continental Shelf Lands Act.Boundary drawing as a method for allocating CEIP funds is analyzed. This method is inadequate to meet the stated purposes of the CEIP and has created needless administrative confusion. (Daniels-Florida)
W80-05371

**GEOTHERMAL DEVELOPMENT AND WESTERN WATER LAW,**
O'Melveny and Myers, Los Angeles, CA.
O. Olpin, A. D. Tarlock, and C. F. Austin.
Utah Law Review, Vol 1979, No 4, p 773-887, 1979. 7 Fig.

Descriptors: *Geothermal studies, *Energy, *Resources development, *State governments, Groundwater resources, Mining, Subsurface investigations, Federal Government, Legal aspects, Energy conversion, Geology.

Geothermal resources currently occupy a small place in United States energy policy. Various estimates of the geothermal potential state that geothermal resources could provide as much as 100,000 megawatts of electrical power for thirty years. Geothermal resources are located primarily in the far west. To exploit a natural resource, some property right in the resource must be established. The laws of hard rock minerals, oil and gas, and water do not provide suitable analogies, because the geothermal resource is direct heat energy ready to be put to use. Several surface owners may be able to tap a common supply, but the supply may be interconnected with other natural resources. It will be undesirable to regulate geothermal resources merely as groundwater resources. The federal government and thirteen western states have some regulation of geothermal development. Applicable state property law for geothermal resources will apply to development on state and privately held land. Conflicts between federal geothermal leases and conventional water users raise more difficult issues. (Wilson-Florida)
W80-05372

**CARACAS, 1974: INTERNATIONAL REGULATION OF OCEAN ECOLOGY.**
Golden Gate Law Review, Vol 5, No 2, p 325-365, Spring 1975.

Descriptors: *Water Pollution Control, *Law of the sea, *Oceans, *Oil pollution, Water pollution sources, Sea water, United Nations, International waters, Waste disposal, International law, Treaties.

The purpose of the 1974 Third United Nations Law of the Sea Conference was to achieve international implementation and agreement for dealing with marine pollution. To define the scope of marine pollution problems, previous attempts at effective control are analyzed. During the 1974 Conference, various draft texts were prepared by subcommittees to form the basis for international agreement on marine environment preservation. No consensus was reached, and the likelihood of a meaningful agreement on pollution control is remote. Nations wishing to act affirmatively must rely on existing conventions and general principles of international law. Increased unilateral action may result with marine pollution control falling victim to expanded claims of ocean jurisdiction by individual nations. This and other possible results of a sluggish international authority are discussed. Alternatives to a world oceans treaty are suggested. (Schwerer-Florida)
W80-05373

**FEDERAL CONTROL OF WATER POLLUTION - AN OUNCE OF PREVENTION IS WORTH A POUND OF CURE,**
Levine and Krom, Beverly Hills.
S. B. Levine.
Beverly Hills Bar Association Journal, Vol 9, No 3, p 34-39, May-June 1975.

Descriptors: *Federal Water Pollution Control Act, *Economic impact, *Water pollution control, Economic efficiency, Industrial wastes, Legislation, Water pollution, Water pollution sources, Water quality control, Effluents, Regulation.

The decade of the 1970's may be considered a pivatal period for improving the environment through the 1972 Federal Water Pollution Control Act Amendments (Act). Major provisions of the new amendments are: (1) a national goal to eliminate pollutant discharge by 1985; (2) construction of publicly-owned waste reatment facilities; (3) iimitations on point source effluents; and (4) mandatory permits for pollution sources. As regulations are issued and legal action instituted pursuant to the amendments, there is increased concern about the need for reliable information on the economic costs of implementing the Act. For example, what are the costs in terms of consumer prices, job losses, relocation and inflation: The issue is whether achieving enhanced water quality is commensurate with the investment of public and private funds. Although management will be somewhat hampered by government involvement in industry and pollution control will obviously cost money, there is no viable alternative to an effective effort to clean up our environment. (Wilson-Florida)
W80-05374

**COMMENTS ON 'FEDERAL RESERVED WATER RIGHTS',**
Debevoise and Liberman, Washington, DC.
J. C. Muys.
Denver Law Journal, Vol 54, No 3-4, p 493-498, 1977.

Descriptors: *Reservation doctrine, *Federal-state water rights conflicts, *Water resources development, Planning, Administrative agencies, State governments, Water rights, Water resources, Water allocation(Policy), Water demand.

In its 1970 report to Congress and the President, the Public Land Law Review Commission evaluated the problems posed by the federal water rights reservation doctrine. The doctrine may disrupt established water right priority systems and destroy vested water rights under state law. Moreover, the uncertainty generated is an impediment to sound planning for future water resources development. Legislative action is needed to dispel this uncertainty and provide the basis for cooperative water resources development planning between the federal government and the state with federal lands. This legislation should include: (1) a requirement that federal land agencies ascertain and give notice of their projected water requirements for the next forty years; (2) establishment of a procedure for determining the reasonableness of diverted water quantities; (3) require, as a condition to claims of reserved water rights, a statement of prospective water requirements, and (4) compensation where utilization of the implied reservation doctrine interferes with vested state water rights. (Wilson-Florida)
W80-05375

**A REAL LIVE PROBLEM OR TWO FOR THE WANING ENERGIES OF FRANK J. TRELEASE,**
Washington Univ., Seattle.
C. Corker.
Denver Law Journal, Vol 54, No 3-4, p 499-505, 1977.

Descriptors: *Reservation doctrine, *Water allocation(Policy), *Federal-state water rights conflicts, Legal aspects, Federal government, Water policy, Diversion, Administrative agencies, State governments, Federal reservations.

All the water diverted as a reslt of the reservation doctrine, excluding Indian water rights, is minimal. The reservation doctrine is essentially mythical for two reasons. First, all water rights have to be administered. Federal officials and agencies have never been created to administer water rights. Federal judges cannot administer water rights without a federal administrator. On the other hand, every state where water is scarce has adopted and administered such a system. Second, water law is not a discrete and separate branch of the law, but is a part of real property law. Most transfers of water rights are accompanied by transfers of land. Practically, if not conceptually, real property law is far beyond the power of Congressional preemption. Moreover, there is no general federal common law. There is no direct danger to water rights as a result of the reservation doctrine. There may be danger instead to the federal system. (Wilson-Florida)
W80-05376

**SAVING THE COAST: THE CALIFORNIA COASTAL ZONE CONSERVATION ACT OF 1972,**
Golden Gate Law Review, Vol 4, No 2, p 307-352, Spring 1974.

Descriptors: *California, *Shore protection, *Conservation, *Zoning, Shores, Land development, Resources development, Seashores, Coastal plains, Legislation, Permits.

The 1972 California Coastal Zone Conservation Act (CCZCA) is a public response to widespread construction along the California coastline. Although most of the coastline is privately held, California citizens and the courts are recognizing a valid public interest in coastal resources. To protect coastal resources until a comprehensive plan can be developed, an interim permit procedure has been established. Analyzed are the interim permit control provisions of the CCZCA, with particular emphasis on: (1) the necessity of compliance with permit provisions; (2) types of permits required; (3) criteria for approval or disapproval of permit applications; and (4) constitutional issues raised by the CCZCA. At the end of the planning phase a permanent coastal commission will be established to monitor development and update plans. The final coastal regulation plan should withstand judicial scrutiny. (Schwerer-Florida)
W80-05377

**COASTAL LAND MANAGEMENT IN CALIFORNIA,**
Houston Univ., TX.
G. L. Finnell, Jr.
American Bar Foundation Research Journal, Vol 1978, No 4, p 647-750, Fall 1978.

Descriptors: *California, *Land use, *Coasts, *Shore protection, Legislation, State governments, Coastal engineering, Management, Administrative agencies, Local governments, Regulation.

The nation's most significant experiment in coastal land management, the one likely to affect the most people's lives, is now under way in California. The program will most likely have national, and perhaps even international, consequences. The 1976 California Coastal Act (1976 Act) continues a coastal planning and regulatory process that began in 1972 when California's citizens approved Proposition 20. Proposition 20 resulted in the creation of the California Coastal Zone Conservation Commission and six regional commissions to accomplish two major objectives: (1) study the coastal zone and prepare the California Zone Conservation Plan; and (2) regulate development by permit in the coastal zone during the studying and planning period. The 1976 Act continues the two functions of coastal plan preparation and interim regulation started in 1972. But local governments are given a stronger role under the 1976 Act, which only sets forth general policies, directing local governments to prepare a local coastal program. The completed local coastal program is submitted to the regional commission that certifies program conformity with the policies of the 1976 Act. (Wilson-Florida)
W80-05378

**PROBLEMS AND PROSPECTS OF COASTAL ZONE MANAGEMENT: AN ENVIRONMENTAL VIEWPOINT,**
Natural Resources Defense Council, New York.
S. Chasis.
Coastal Zone Management Journal, Vol 6, No 4, p 273-280, 1979.

Descriptors: *Coasts, *Shore protection, *Land use, Federal government, Legislation, Decision-making, Environmental effects, Administrative decisions, Administration, State governments, Local governments.

The 1972 Coastal Zone Management Act (Act) is not effectively addressing the problems Congress recognized when the law was passed. It is not ensuring protection of our valuable coastal resources, mainly because the Act has been interpreted as a neutral planning process which emphasizes decision-making procedures at the expense of policy substance. Planning and management do not exist for their own sakes; procedures without substantive content are meaningless. Many states structures now exist that begin to deal with coastal problems. Current management problems are discussed, and recommendations to strengthen coastal zone management programs are presented. One source of the problems is the statute itself - the stated purposes are too broad. Also, implementation at the federal and state level has not been as vigorous as it should have been. More vigorous implementation is necessary to ensure the original goals of the Act are met. A national policy must be established and implemented. The principles on which such a policy should be based are listed. (Daniels-Florida)
W80-05379

**PROLEGOMENA TO THE DISPUTES SETTLEMENT PART OF THE LAW OF THE SEA CONVENTION,**
A. O. Adede.
New York University Journal of International Law and Politics, Vol 10, No 2, p 253-393, Fall 1977. 2 App.

Descriptors: *Law of the sea, *United Nations, *Remedies, Treaties, Conferences, Decision-making, International law, International waters, Water law, Negotiations.

Most of the substantive treaty negotiations before the United Nations Conference (Conference) on the Law of the Sea have been undertaken in informal meetings of the Conference committees. This article provides an analysis of Part XV of the current draft Law of the Sea Convention (The Informal Composite Negotiating Text) which deals with disputes settlement. Documents containing draft articles on the subject of disputes settlement produced by each session of the Conference are analyzed. The key issues are identified, and their treatment is analyzed at the various stages of the negotiations. Disputes settlement was dealt with in two stages at the Conference. First was the work of the Informal Working Group. The second stage was the informal meetings of the plenary Conference representing the official treatment of the subject. The Informal Working Group made a significant contribution to the development of the disputes settlement treaty articles. (Daniels-Florida)
W80-05380

**STATE-LOCAL RELATIONS IN COASTAL ZONE MANAGEMENT IMPLICATIONS FOR CHANGE,**
California Univ., San Diego. Inst. of Marine Resources.
J. Sorensen.
Coastal Zone Management Journal, Vol 6, No 4, p 295-302, 1979.

Descriptors: *State governments, *Local governments, *Governmental interrelations, *Shore protection, Federal government, Legislation, Coordination, Coasts, Planning, Management, Land use.

Changes in intergovernmental relations have been one of the main effects of the Coastal Zone Management Act (Act). A rearrangement in state-local government relations is one of the Act's major achievements. However, state-local relations could be improved by legislative amendments. One type of arrangement dominates the state-local relationships: Collaborative Planning Process (CPP). The CPP is not the most appropriate coastal management implementation arrangement for all states. The Act should be redrafted to clarify Congressional intent in coastal zone management. The Act should recommend to states using or considering CPP that the process incorporates three additional state powers. Additional amendments should require the Office of Coastal Zone Management to review substantial changes in local coastal plan components of a state's approved program. The Act's two greatest impacts, in states with CPP, have been to improve local governments planning capabilities and improved communication between state and local governments. (Daniels-Florida)
W80-05381

**MANAGEMENT OF LIVING RESOURCES IN THE NORTHEAST PACIFIC AND THE UNILATERAL EXTENSION OF THE 200-MILE FISHERIES ZONE,**
Washington Univ., Seattle. Inst. for Marine Studies.
D. Fluharty, and C. Dawson.
Ocean Development and International Law Journal, Vol 6, p 1-72, 1979. 19 Tab, 1 Bib.

Descriptors: *Jurisdiction, *Resources development, *Fisheries, *Law of the Sea, Resources allocation, International waters, International Law, Regional analysis, Regional development, Management, Resources, Oceans.

The emergence of a 200-mile economic zone, within which coastal states have exclusive control over marine resources, scientific research and pollution, will produce immediate and interacting effects. The need will intensify for increased bilateral and multilateral consultations, and a new level of coordination to cope with impending changes in use patterns. Recent demands for expanded jurisdiction seldom consider the policies and organizational networks needed for coordinated management and conflict resolution on regional or subregional levels. The need for a policy-oriented approach to multiple usage problems is addressed, with the world's oceans divided into marine regions. A marine regiona is a marine area in which the pattern of management problems posed by different activities is at least analytically separable from the rest of the world ocean. With the North Pacific Ocean as an example, the different approaches are analyzed which coastal states within marine regions can use to determine 'net benefit', corrdinate management, and resolve regional conflicts. (Daniels-Florida)
W80-05382

**LIQUEFIED NATURAL GAS TERMINAL SITING IN THE CALIFORNIA COASTAL ZONE: THE SCOPE OF PERMISSIBLE STATE AUTHORITY,**
J. C. Arnold.
Pacific Law Journal, Vol 9, No 2, p 1069-1113, July 1978.

Descriptors: *California, *Natural gas, *Sites, *Shore protection, Liquids, Energy, Facilities, Coasts, Legal aspects, State governments, Environmental effects, Federal government.

With the enactment of the 1977 Liquefied Natural Gas Terminal Act (Act) California has committed itself to the importation by sea of liquefied natural gas as a primary energy source for the foreseeable future. Further siting criteria are necessary to govern construction of additional liquid natural gas facilities in the California coastal zone. Regardless of whether the state or federal government has the power to establish ultimate siting criteria for import terminals, the nature of liquid natural gas and the potentially disastrous impact of a massive accident compel governmental consideration of the siting issue. Onshore as opposed to offshore siting,

and remote as opposed to populated site locations, are topics of current and continued public concern that must eventually be dealt with at the federal or state level. The Act raises the question of whether the state may constitutionally enforce the statute in the face of federal preemption. The present federal statutory scheme indicates an intent that states retain a significant degree of control over liquid natural gas facility siting. (Daniels-Florida)
W80-05383

**COASTAL ENERGY IMPACT PROGRAM: REGULATIONS TO ESTABLISH THE OUTER CONTINENTAL SHELF (OCS) STATE PARTICIPATION GRANT PROGRAM (FINAL RULES).**
Department of Commerce, Washington, DC.
Federal Register, Vol 45, No 14, p 4306-4311, January 21, 1980.

Descriptors: *Grants, *Continental shelf, *Resources development, *Governmental interrelations, State governments, Oil, Leases, Government finance, Management, Planning, Environment.

These final regulations describe administrative procedures for implementing section 308(c) (2) of the 1972 Coastal Zone Management Act. The Outer Continental Shelf State Participation Grant Program is established which provides financial assistance for coastal state participation in policy, planning, and managerial decisions related to continental shelf oil and gas resources management. The Assistant Administrator is authorized to make grants to coastal states likely to be affected by Outer Continental Shelf energy activity, provided these states are eligible to receive Coastal Energy Impact Program assistance. These grants are intended to pay for state participation in formulating leasing programs, reviewing environmental impact statements, making recommendations for exploration and development, and analyzing program data. Each state receives an equal minimum share. After this, remaining funds are alloted according to a formula. Each state has thirty days to comment upon the formula applied to it. The regulations also set out the proper contents of a grant application. Each state has 120 days to apply for its allotment, or it reverts back to the Assistant Administrator for redistribution. (Tabano-Florida)
W80-05384

**FISHERMEN'S CONTINGENCY FUND (FINAL REGULATIONS).**
Department of Commerce, Washington, DC.
Federal Register, Vol 45, No 17, p 6062-6078, January 24, 1980.

Descriptors: *Compensation, *Continental shelf, *Damages, *Commercial fishing, Fishing gear, Governments, Assessments, Leases, Easements, Permits.

The regulations establish procedures for administering the Fishermen's Contingency Fund. This Fund compensates fishermen for eligible claims for actual and consequential damages. Lost profits due to damages to, or loss of, fishing vessels or gear by activity associated with oil and gas exploration, development, or production on the Outer Continental Shelf are recoverable. The Fund is set up in the United States Treasury and consists of nine area accounts. Assessments are made against leases, easements, and exploration permits relating to the Outer Continental Shelf in order to fund each area account. Eligibility for compensation requires that the claimant be a commercial fisherman. The procedure for computation of damages is set forth. The regulations also set forth instructions for filing claims. The chief of the Financial Services Dicision and the Secretary of the Interior both take part in processing claims. The burden of demonstrating eligibility for, and the amount of, compensation is upon the claimant. Costs of the proceeding are paid by the person responsible for the damage. The government is subrogated to any other rights the claimant may have against any person in another proceeding. (Tabano-Florida)
W80-05385

**RATIONAL DEVELOPMENT OF OUTER CONTINENTAL SHELF OIL AND GAS,**
Senate, Washington, DC.
H. M. Jackson.
Oregon Law Review, Vol 54, No 4, p 567-581, 1975.

Descriptors: *Continental shelf, *Resources development, *Oil, *Gases, Exploration, Legislation, Federal government, Environmental effects, State governments, Energy, Programs.

The United States domestic energy production effort should be directed toward increasing the rate of exploration and development on the Outer Continental Shelf (OCS). Obstacles to OCS gas and oil development are technological, economic, environmental, legal and administrative. Policy issues are: (1) development rate and location; (2) environmental safeguards; (3) role of and impact on coastal states; (4) extent of federal government participation; (5) access to industry information; and (6) resource allocation. Congress must update the 1953 Outer Continental Shelf Lands Act to provide authority and guidelines for development activity. The history of the OCS Act and OCS resource development is examined. The OCS contains large amounts of undiscovered oil and gas resources, and demonstrated reserves of almost one billion barrels of oil and one trillion cubic feet of gas. The major provisions of the proposed 1975 Energy Supply Act are discussed. This Act contains needed changes in the law that allow people to retain control over their resources. (Daniels-Florida)
W80-05386

**TRENDS IN ENVIRONMENTAL LITIGATION: A SURVEY OF 1976 NEW JERSEY JUDICIAL DECISIONS,**
L. Goldshore.
Rutgers Camden Law Journal, Vol 9, No 1, p 21-59, Fall 1977.

Descriptors: *New Jersey, *Shore protection, *Water resources, *Land use, Environmental effects, Coasts, Wetlands, Legislation, Regulation, Public access, Environmental control, Administrative agencies, Judicial decisions.

In 1976, New Jersey courts dealt with a variety of environmental issues: (1) the balancing and integration of environmental goals with other societal needs; (2) cost allocation for attaining governmental objectives; (3) the validity of environmental protection statutes and regulations; and (4) the application of general statutes to specific environmentally-related factual contexts. The Department of Environmental Protection (DEP) wetlands hearing regulations were upheld against attack by a conservation group. The state's supreme court decided that the public trust doctrine prohibited a municipality from discriminating between residents and non-residents. As to water resources issues, the New Jersey courts heard cases dealing with thermal pollution, oil spills, flooding and sewerage authorities. There were several exclusionary zoning cases, in which municipalities argued that environmental considerations prohibited development of low-cost housing. As to outdoor recreational issues, the constitutionality of statutory provisions for selecting members of the Fish and Game Council were upheld. Statutes were interpreted dealing with out-of-state solid waste, the Solid Waste Management Act, and the Solid Waste Utility Control Act. (Wilson-Florida)
W80-05387

**GEOTHERMAL LEASING,**
R. J. Werner.
Oregon Law Review, Vol 54, No 4, p 623-641, 1975.

Descriptors: *Water resources development, *Leases, *Geothermal studies, *Steam, Legislation, Federal government, Legal aspects, Resources, Public lands, Energy, Water resources.

Geothermal steam has tremendous electrical energy potential. Concentrations of geothermal energy, economically feasible to extract, are in geothermal reservoirs. There are three requirements geothermal reservoirs must meet for economical exploitation. By 1985, ten percent of the United States (U.S.) energy needs could be produced from these reservoirs. Exploration presently is occuring in some western states. Before 1970, no statutory authority permitted the disposition of geothermal resources on public lands, where much geothermal potential exists. The 1970 Geothermal Steam and Associated Geothermal Resources Act (Act) encouraged development through a system of privately held leases. The Act provides guidelines to what lands are subject to leasing. Lease holders are limited to U.S. citizens, associations of citizens, corporations and governmental units. A 'grandfather' clause is included. Certain aspects of the Act's regulatory provisions are discussed: extraction of by-products; minerals excepted from leases; mineral lease conversion; effect on state water laws; surface use; and lease procedures and assignment. Certain lease terms are discussed: duration; leasehold area; rents and royalties; readjustment; and other miscellaneous terms. It is unclear whether minerals reserved to the U.S. in patents previously issued apply to geothermal resources. (Daniels-Florida)
W80-05388

**CONTROLLING MARINE POLLUTION - WORLD TASK OR NATIONAL.,**
Texas Univ. at Austin.
W. L. Butte.
Stanford Journal of International Studies, Vol 8, p 99-112, Spring 1973.

Descriptors: *Oceans, *Pollution abatement, *International waters, *Law of the sea, United Nations, United States, International law, Legislation, Conferences, Regimes, Negotiations.

An international solution to ocean pollution will create problems of indefinite delay and inconclusive results. The language used in Article 25 of the 1958 Geneva Convention on the High Seas is an example of the problems inherent in looking for an international solution. The 1972 United Nations (U.N.) Conference on the Human Environment in Stockholm attempted to deal with marine pollution. It could not agree on anything specific or concrete. Its Declaration is not binding on any states. The preparatory work undertaken for the 1973 U.N. Conference on the Law of the Sea indicates problem-solving will be attempted by creating new committees and agencies. Direct confrontations will be avoided. Generalized objectives would not be binding. Alternative methods to the U.N. machinery to solve ocean pollution are compared. These include multilateral, bilateral or unilateral action. Developed nations must solve ocean pollution, either alone or through negotiations among the industrialized states. (Daniels-Florida)
W80-05389

**U.S. POSITION ON NEGOTIATIONS CONCERNING THE GREAT LAKES,**
Department of State, Washington, DC.
D. Burns.
Syracuse Journal of International Law and Commerce, Vol 1, No 2, p 199-204, Fall 1973.

Descriptors: *Great Lakes, *United States, *Canada, *Boundary disputes, International Joint Commission, Negotiations, Boundaries(Surface), Water pollution, Treaties, Water pollution control, Water quality control, Monitoring.

Attempts at resolution of boundary water problems have played a dominant role in United States-Canadian relations over the years. In 1909, the two countries concluded the Boundary Waters Treaty (Treaty). The 1909 Treaty created the International Joint Commission (Commission), which has the principle function of passing on applications to use, divert, or obstruct waters covered by the Treaty. Article IV of the Treaty provides that the waters covered therein shall not be polluted by either side. Shortly after its establishment, the Commission was requested to look into questions of water pollution. The Commission has made recommendations to both governments with respect to various questions of boundary waters pollution. Both par-

ties have agreed that the Commission should monitor water pollution. The Commission's 1970 report is the basis on which the Great Lakes Duality Agreement has been negotiated. The principle recommendations of the Commission are: (1) adoption of common water quality objectives; and (2) continued Commission monitoring. (Daniels-Florida)
W80-05390

**COMPARATIVE NATIONAL LEGISLATION ON OFFSHORE POLLUTION,**
United Nations Secretariat. Office of Legal Affairs.
M. Hayashi.
Syracuse Journal of International Law and Commerce, Vol 1, No 2, p 250-256, Fall 1973.

Descriptors: *Foreign countries, *Oil pollution, *Continental shelf, Water pollution, Environmental control, Legal aspects, International commissions, Water pollution control, International law, Oil spills.

National legislation on marine pollution can be classified into four types: (1) provisions concerning the development of continental shelf resources; (2) laws enacted pursuant to the 1954 London Convention for the Prevention of Pollution of the Sea by Oil (London Convention); (3) those containing the elements covered by the London Convention and the 1969 Brussels Convention on oil pollution casualties; and (4) laws which do not fall into the above three categories. In the first category, most of the provisions are based on the Geneva Convention on the Continental Shelf. This states that continental shelf exploration must not result in unjustifiable interference with navigation, fishing or conservation. Nations with this type of legislation include Italy, Sweden, Venezuela, and the United States. The United States also has legislation that compacts with the London Convention. Similar laws are in effect in France, Ghana, Kuwait, and Spain. The third category consists of more comprehensive laws, such as the British Oil in Navigable Waters Act of 1971. Lastly, some national laws have unique features not present in the other categories. An example is the Australian Navigation Act. (Wilson-Florida)
W80-05391

**THE RIGHTS AND LIABILITIES OF A MINERAL OWNER CONCERNING THE USE OF WATER,**
K. C. Raney, Jr.
South Texas Law Journal, Vol 17, No 3, p 510-524, 1976.

Descriptors: *Texas, *Mineral industry, *Water rights, *Water allocation(Policy), Water demand, Judicial decisions, Mining, Subsurface waters, Surface waters, Mine water, Water law.

The increased mining of hard minerals in Texas has created great conflict between the rights of mineral owners and other water users involving the same supply of water. The use of water by mineral producers has created some novel situations that past legislatures and courts could not have anticipated. A mineral owner's right to use water can be determined by classifying water into two categories, either subterranean water or non-subterranean water. Subterranean water is either an underground stream or percolating water. This distinction is important with respect to claims of water ownership. With percolating water, the problem is one of determining rights between users. As a general rule, a surface owner has the right to use the surface water on his property. The issue remains whether a mineral lessee has the right to use or drain surface water as a reasonable use of the surface estate in mining his claim. The right to mine and the right to use water must be reconciled where conflicting to provide an effective water policy. (Wilson-Florida)
W80-05392

**JUDICIAL DEFERENCE IN THE SUBMERGED LANDS CASES,**
Vanderbilt Univ., Nashville, TN.
J. I. Charney.
Vanderbilt Journal of Transnational Law, Vol 7, No 2, p 383-455, Spring 1974.

Descriptors: *Judicial decisions, *Beds under water, *Legal aspects, Constitutional law, Constraints, Adoption of practices, Adjudication procedure, Legal review, Jurisdiction, Water law.

In many areas of foreign relations, the United States (U.S.) Supreme Court has determined the judiciary should exercise restraint and defer to the wishes of the Executive Branch. This judicial restraint and deference may be appropriate in submerged lands cases. The Supreme Court has failed to identify factors that require judicial restraint. The primary subject matter areas in which judicial restraint has been exercised are recognition, sovereign immunity, state acts, treaty interpretation and territorial questions. Twelve significant court decisions in the submerged lands dispute are reviewed. Initially, the Supreme Court exercised restraint in submerged lands disputes, believing their decisions might affect the U.S. territorial boundary. This restraint became tempered; most recent decisions minimize deference to the Executive branch. A review of the submerged lands issues indicates deference should play no role in submerged lands cases. (Daniels-Florida)
W80-05393

**INTERNATIONAL STRAITS, GLOBAL COMMUNICATIONS, AND THE EVOLVING LAW OF THE SEA,**
W. G. Grandison, and V. J. Meyer.
Vanderbilt Journal of Transnational Law, Vol 8, No 2, p 393-449, Spring 1975.

Descriptors: *Law of the Sea, *Communication, *Straits, International law, International waters, Navigation, Legal aspects, Oceans, Jurisdiction, Regimes.

Extending territorial seas to twelve miles will cause over 100 straits to be overlapped by the territorial sea. Existing international legal norms preserving navigational freedom and overflight between ocean areas will be altered. Controversy ensues over what legal regime should govern the traffic in these straits. Communications issues raised by the proposed extention are focused on. A legal regime is suggested to resolve current legal controversies, and to provide continuity in the law governing international communications within these straits. The evolving law of the sea and the events leading to the straits controversy are examined. The role of straits in ocean communications, the interests of states relying on the use of straits for communications and the interest of coastal states bordering straits are explored. There are general legal trends supporting global communications. Different legal approaches to the control and regulation of communication and to the allocation of authority to control communication in straits are examined. A new straits regime must guarantee to all nations use of and access to communications media in straits. (Daniels-Florida)
W80-05394

**CANADA'S INTERESTS AS REGARDS PROTECTION AND REGULATION OF THE GREAT LAKES,**
Department of External Affairs, Ottawa (Ontario). Bureau of Economic and Scientific Affairs.
K. Wardroper.
Syracuse Journal of International Law and Commerce, Vol 1, No 2, p 205-222, Fall 1973.

Descriptors: *Canada, *Great Lakes, *Water pollution control, *United States, International Joint Commission, Water pollution, Boundaries(Surfaces), United States, Negotiations, Treaties, Environmental control.

In 1964 the Boundary Waters Treaty launched the International Joint Commission into an intensive examination of the water conditions in the lower Great Lakes. In 1970 the Commission reported there was extensive tran-boundary pollution in the area. This report also proposed five general objectives to which both the United States and Canada should address themselves. These objectives state that the waters of the Great Lakes should be: (1) free from substances or solids attributable to municipal discharges; (2) free from floating debris and other discharges in unsightly or deleterious amounts; (3) free from odor-producing material attributable to municipal discharges; (4) free from nutrients; and (5) free from hazardous and toxic substances. These general objectives, in order to be translated into meaningful intergovernmental undertakings, have been presented as numerous specific objections. Under a proposed agreement, the governments concerned would exchange commitments to carry out a variety of pollution control programs. These programs include: (1) construction of treatment facilities; (2) reduction of phosphorus discharges; (3) elimination of mercury from discharges; and (4) control of pesticide pollution. (Wilson-Florida)
W80-05395

**ENVIRONMENTAL LAW - A SURVEY OF INTERNATIONAL MARINE POLLUTION CONTROL: PRELUDE TO GENEVA,**
P. B. Barr, Jr.
Vanderbilt Journal of Transnational Law, Vol 8, No 2, p 477-492, Spring 1975.

Descriptors: *Water pollution control, *International commissions, *Law of the sea, *United Nations, International law, Treaties, Environmental control, International waters, Water pollution, Foreign countries, Oceans.

Treaties, conventions, and agreements relative to marine pollution are myriad. Summaries of modern international efforts to prevent pollution begin with the 1954 Convention for the Prevention of Pollution of the Sea by Oil. Several United Nations Conventions drafted at the First Law of the Sea Conference, now in force, incorporate provisions designed to protect the marine environment. Nations that share marine resources because of geographical proximity have begun to recognize common pollution problems. An example of such a regional agreement is the Committee on the Challenges of a Modern Society established the North Atlantic Treaty Organization in 1969. Marine pollution has recently become an area of cooperation between the United States and the Soviet Union. A 1972 agreement anticipates joint study and development of coordinated projects in basic and applied sciences. Non-governmental bodies, such as the International Council of Scientific Unions, have also become involved in prevention of marine pollution. Recent United Nations approaches include the 1972 Stockholm Conference on the Human Environment and the 1974 Conference on the Law of the Sea. (Wilson-Florida)
W80-05396

**NATIONAL WATER POLICY IN THE WAKE OF UNITED STATES V. NEW MEXICO,**
New Mexico Water Resources, Santa Fe.
R. A. Simms.
Natural Resources Journal, Vol 20, No 1, p 1-16, January 1980.

Descriptors: *Federal reservations, *Federal-state water rights conflicts, *Reservation doctrine, *Water allocation(Policy), Judicial decisions, Water policy, Water rights, Federal government, Legal aspects, Water users, State governments.

In a 1978 decision, the United States (U.S.) Supreme Court limited federal reserved right claims to the Rio Mimbres drainage of the Gila National Forest. They were limited to an amount of water necessary to satisfy the purposes for which the forest lands were withdrawn from the public domain. The federal government has reacted by reassessing its posture in water rights litigation in various western states, and by creating a conceptually new basis upon which to assert its claims. The U.S. Solicitor General has asserted that the U.S. has always retained a residual right to use non-navigable western waters for congressionally mandated purposes, independently of the reservation doctrine. This doctrine of 'non-reserved federal water rights' attempts to circumvent rather than adhere to the Court's decision. Moreover, President Carter has made assurances that his water policy reforms will not undermine state preroga-

tives in water rights administration. When acting on the President's water policy recommendations, Congress should not ignore the views of western water officials. (Wilson-Florida)
W80-05397

**ABORIGINAL WATER RIGHTS,**
Yegge, Hall and Evans, Denver, CO.
J. L. Merrill.
Natural Resources Journal, Vol 20, No 1, p 45-70, January 1980.

Descriptors: *Water rights, *Federal reservations, *Indian reservations, Federal government, State governments, Water demand, Water users, Legal aspects, Prior appropriation, Federal-state water rights conflicts.

An aboriginal water rights, one which was the first of its kind in a region, is based on the water use from earliest days. A water right which predates federal sovereignty is sufficient to render that right aboriginal vis-a-vis the United States. Aboriginal rights constitute a potentially great threat to present water users because they may displace federal water rights and those held under state prior appropriation law. Aboriginal water rights have greatest potential impact in the western states. Aboriginal rights were judicially decreed in a 1935 case and exist as pueblo water rights in California and New Mexico. Little else has been heard about them until recently. Native American Indian tribes have begun to claim they have always held and now hold aboriginal water rights. Several aspects of aboriginal water rights deserve exploration: (1) their relationship to the federal Winters Doctrine; (2) state court jurisdiction over aboriginal rights; (3) groundwater; and (4) the uses to which these waters might be put. (Wilson-Florida)
W80-05398

**CONSIDERATIONS AND CONCLUSIONS CONCERNING THE TRANSFERABILITY OF INDIAN WATER RIGHTS,**
J. D. Palma.
Natural Resources Journal, Vol 20, No 1, p 91-100, January 1980.

Descriptors: *Water rights, *Federal reservations, *Water transfers, *Indian reservations, Federal government, Federal-state water rights conflicts, Judicial decisions, Water allocation(Policy), Prior appropriation, Legal aspects, Water demand, Water users.

As a consequence of the United States (U.S.) Supreme Court decision in Colorado River Water Conservation District v. U.S., there has been intensified adjudication of Winters Doctrine water rights between the states and the U.S. and/or their Indian wards. Courts have applied various standards to determine the water quantity reserved under the Winters Doctrine. Regardless of what test is utilized to quantify these Indian water rights, the tribes will obtain prior and, in most cases, paramount rights to vast water quantities. An important issue is the transferability of Indian water rights to new uses within the Indian reservation boundaries. Since most of the water claimed under the Winters Doctrine has not yet been put to beneficial use, there is a question about the water quantity transferable to a new use. An additional issue concerning the transferability of Winters rights involves the rights of purchasers of land formerly a part of the reservation. (Wilson-Florida)
W80-05399

**RES JUDICATA - WILL IT STOP INSTREAM FLOWS FROM BEING THE WAVE OF THE FUTURE.,**
Department of the Interior, Albuquerque, NM. Field Solicitor's Office.
H. A. Ranquist.
Natural Resources Journal, Vol 20, No 1, p 121-151, January 1980.

Descriptors: *Prior appropriation, *Streamflow, *Water rights, Indian reservations, State governments, Streams, Judicial decisions, Water distribution(Applied), Legal aspects, Diversion.

The instream flows issue is arising in water rights litigation in the west. Until recently the western states have denied that instreams had any place in the appropriation system. As the move to establish instream flows increases, present water users are rising in opposition. A barrier which opponents of instream flows will erect is the claim that western streams are fully appropriated and adjudicated, leaving little or no room for the exercise of instream flows. They argue that the legal bar to further litigation under the doctrines of res judicata and collateral estoppel will shield against instream water claims. However, the unique nature of water and the water adjudication process, particularly quit title proceedings, results in many water uses not being subject to bars against further litigation. If diversion from streams is restricted to effective beneficial use, water will be available to establish instream flows in some streams despite the applicability of the bar to further action. (Wilson-Florida)
W80-05400

## 6F. Nonstructural Alternatives

**SAVING THE COAST: THE CALIFORNIA COASTAL ZONE CONSERVATION ACT OF 1972.**
For primary bibliographic entry see Field 6E.
W80-05377

## 6G. Ecologic Impact Of Water Development

**WATER AND THE ENVIRONMENT -- A SCOTTISH SOLUTION,**
Cutherbertson (Rober H.) and Partners, Edinburgh (Scotland).
W. P. McLeish, and D. Mackie.
Water, No 31, p 11-14, March 1980. 5 Fig, 3 Ref.

Descriptors: *Environmental effects, *Scotland, *Water supply development, Water supply, Reservoirs, Water demand, Project benefits, Land use, Water sources, Aqueducts, Ecology, Impact studies, Evaluation, Analytical techniques, Classification.

The findings and methods used in a comparative environmental examination of the three preferred schemes for the treating of water from new sources and conveying it to selected distribution points in Scotland are discussed. The three schemes are: the Clyde scheme, based on a large regulating reservoir on an upper tributary; the fourth scheme based on two regulating reservoirs; and the Tay scheme based on direct abstraction from the river. The study was designed to gather information on the characteristics of the areas involved, the activities in those areas, the impacts of the proposals on these characteristics and activities, and the capability of the proposals for modification to elimanate environmental problems. The information gathered from various agencies was combined to form an 'impact matrix' for each subarea involved. Impacts were classified as long term benefit, short term benefit, no benefit or disbenefit, short term disbenefit, or long term irreversible disbenefit. Results show that in environmental terms, the Tay scheme is the most desirable plan due to the fact that it will not produce long-term deleterious irreversible effects. Results also show that the Clyde scheme would have the most damaging environmental effects. (Seigler-IPA)
W80-05117

**ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE, PART A: ROCKY MOUNTAINS AND PACIFIC NORTHWEST, EXECUTIVE SUMMARY,**
Enviro Control, Inc., Rockville, MD.
W. Nelson, G. Horak, M. Lewis, and J. Colt.
U.S. Fish and Wildlife Service, Office of Biological Services Report FWS/OBS/-76/28. December, 1976. 14 p.

Descriptors: *Rocky Mountain region, *Pacific Northwest U.S., *Wildlife habitat, *Water resources development, Streamflow, Wildlife, Dams, Alteration of flow, Fisheries, Water resources, *Altered streamsflow, Environmental effects, Ecology.

A detailed summary, evaluation, and a series of recommendations is provided on the impacts of 109 instream flows distributed in nine western states. The introductory discussion explains the background, purpose, and methodology of the research. The more significant conclusions are summarized in the next section. These conclusions are utilized in the final section as the basis for key recommendations for improving the process of instream flow reservation and implementation. (Steiner-Mass)
W80-05323

**ASSESSMENT OF EFFECTS OF ALTERED STREAM FLOW CHARACTERISTICS ON FISH AND WILDLIFE. PART B: CALIFORNIA, EXECUTIVE SUMMARY,**
Jones and Stokes Associates, Inc., Sacramento, CA.
C. Hazel.
U.S. Fish and Wildlife Service, Office of Biological Services Report FWS/OBS-76/32. December, 1976. 14 p.

Descriptors: *California, *Wildlife habitat, *Water resources development, *Stream flow, Wildlife, Dams, Alteration of fflow, Fisheries, Water resources, Fish management, *Altered streamflow, Environmental effects, Ecology.

Forty-six projects were investigated and evaluated to identify the discernible effects of post-project flows on pre-project fish and wildlife and to evaluate the success and effectiveness of various methodologies used to predict project effects. Each project was reviewed and evaluated through a literature search, review of files, interviews with project biologists, and visits to the project site. Conclusions were: The methodology for obtaining instream flows for fish and wilflife in California are insufficiently documented and publicized. Information about the quantity of water potentially available for fish and wilflife was usually not made available to the fisheries agencies. Average monthly post-project flows of about 0.7 or less of the pre-project flow during critical periods are degrading to fisheries and decreases to 0.3 or less severly damage or lead to the extinction of the principal fisheries. Projects that divert water from the reservoir pool are most damaging to fish. On the other hand, projects that utilize the river channel to convey project water to users are most likely to maintain or improve the pre-project fishery. (Steiner-Mass)
W80-05324

**THE URBAN COAST FROM A NATIONAL PERSPECTIVE,**
National Oceanic and Atmospheric Administration, Office of Coastal Zone Management.
For primary bibliographic entry see Field 6E.
W80-05363

**COASTAL ZONE MANAGEMENT: THE FIRST FIVE YEARS AND BEYOND,**
National Oceanic and Atmospheric Administration, Washington, DC.
For primary bibliographic entry see Field 6E.
W80-05366

**A PETROLEUM INDUSTRY PERSPECTIVE ON FEDERAL COASTAL ZONE MANAGEMENT,**
American Petroleum Inst., Washington, DC.
For primary bibliographic entry see Field 6E.
W80-05367

**COASTAL LAND MANAGEMENT IN CALIFORNIA,**
Houston Univ., TX.
For primary bibliographic entry see Field 6E.
W80-05378

# 7. RESOURCES DATA

## 7B. Data Acquisition

**AN INVESTIGATION OF SATELLITE-RADAR CORRELATION FUNCTIONS,**
Eddy (Amos) Inc., Norman, OK.
L. A. Hembree.
Available from the National Technical Information Service, Springfiled, VA 22151 as PB80-176001, Price codes: A11 in paper copy, A01 in microfiche.

Descriptors: *Radar, *Remote sensing, *Satellites(Artificial), *Rainfall, Montana, Model studies, Mathematical models, Storm structure, Meteorology, Methodology, Analysis, Infrared radiation, Rain gages, Weather data, Precipitation(Atmospheric), Weather patterns.

Space time correlation fields were used to combine radar and satellite data sets to improve estimates of surface precipitation. Data used in the study included rain gage, radar, and satellite observation derived from the HIPLEX (High Plains Cooperative Program) project at Miles City, Montana. The radar data consisted of digitized 5 cm radar returns from 5 minute scans of 12 elevation angles, however, only the 1 degree angle was used. Satellite data consisted of visible reflectance and IR radiance. Temperature gradients were calculated since the highest temperature gradient should be associated with higher rain rates. Four convective complexes were analyzed in detail using a multivariate optimal interpolation objective method of analysis. The correlation fields were used to represent the storm structures as implied by observed data. A four-dimensional Gaussian damped cosine function with parameters reflecting storm characteristics was used to model the correlation fields. Results show that suitable correlation fields can be obtained with respect to auto-correlation fields. For cross-correllation fields, which tend to be multimodal, a more general correlation model may be needed. Correlation values of 0.6 between satellite and radar rain data were reached at the appropriate space-time lags for maximizing pattern correspondence. The potential value of the multivariate objective analysis methodology is established. (Seigler-IPA)
W80-05110

**USERS GUIDE FOR THE ANALYSIS AND INTERPRETATION OF SATELLITE IMAGERY ON THE HIGH PLAINS SUMMER CLOUD AND MESOSCALE SYSTEMS,**
Water and Power Resources Service, Denver, CO. Div. of Research.
D. A. Matthews.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-175987, Price codes: A03 in paper copy, A01 in microfiche. Report, January 1980. 44 p, 17 Fig, 2 Tab, 17 Ref.

Descriptors: *Remote sensing, *Satellites(Artificial), *Cloud physics, *Precipitation(Atmospheric), Meteorological data, Weather data, Synoptic analysis, Weather modification, Cloud seeding, Storms, Montana, Texas, Kansas, Atmospheric physics, Air temperature, Air circulation.

Examples of typical cloud types and mesocale organized cloud systems which affect summertime precipitation on the High Plains are illustrated and discussed to aid in the interpretation of satellite imagery and to provide a guide for uniform classification. The examples are taken from conditions over the High Plains at the Water and Power Resources Service HIPLEX (High Plains Cooperative Program) field sites in Montana, Kansas, and Texas. Nine types of mesoscale organization visible in geosynchronous satellite imagery are illustrated: mountain orographic cumulus, convergence lines (lines of convective clouds), vorticity sheet (line of intense lateral shear), cloud street of cumulus, jetstream, cirrus bands, mesohigh associated with thunderstorms, cloud clusters, differential heating due to low stratus and fog, and upslope stratiform conditions. The cloud categories used are: clear, small cumulus (very small, wide spread, haze like), small cumulus (distinct cells), cumulus congestus, cumulonimbus, stratocumulus, stratus, altocumulus, altocumulus castellatus, and cirrus. Methods used to identify these categories are described to aid user interpretation of information available on visible satellite imagery. Three examples of synoptic characteristics inferred by cloud patterns are also illustrated and discussed. (Seigler-IPA)
W80-05111

**STOCHASTIC ANALYSIS OF ANNUAL RAINFALL AFFECTED BY URBANIZATION,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 2B.
W80-05119

**BED LOAD: DEFINITION AND MEASUREMENT,**
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
P. J. Murphy, and M. I. Amin.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 759-766, 1978. 7 Fig, 3 Ref. NSF ENG76-17263.

Descriptors: *Bed load, *Model studies, *Bed load samplers, Sediments, Movement, Particle size, Hydraulic models, Sampling, Bottom sampling, Sediment transport, On-site tests, Analytical techniques, Analysis.

The purpose of this paper was twofold: (1) to explain the difference between bed load and suspended load, and (2) to report the development of a compartmented pit sampler. A particle is defined to be in a turbulent suspension during the time it is carried beyond the bounce limit by the supportive turbulent velocity fluctuations. The rest of the time it moves as bed load. A depiction of this definition was given schematically. The compartmented trap is composed of a watertight box, its sliding cover, and a large number of removable compartments. During a test the compartments are filled with the sediment that moves along the bottom of the streambed. Since the compartments in the downstream end of the trap can catch only those particles that have jumped over the containers in the upstream end of the trap, the downstream compartments catch a smaller mass of moving sediment than do the upstream ones. This variation in the deposition of the sediment permited the calculation of the fraction of the total sediment sample with a particular jump length. (See also W80-05159) (Humphreys-ISWS)
W80-05231

## 7C. Evaluation, Processing and Publication

**SMOOTHED DATA AND GRADIENTS USING SLIDING POLYNOMIALS WITH OPTIONAL CONTROLS,**
Science and Education Administration, Athens, GA. Southeast Watershed Research Program.
W. M. Snyder.
Water Resources Bulletin, Vol 16, No 1, p 22-30, February 1980. 10 Fig, 4 Tab, 11 Ref.

Descriptors: *Data processing, *Analytical techniques, *Analysis, Computer programs, Regression analysis, Climatic data, Weather data, Hydrologic data, Sliding polynomials, Smoothed data, Data smoothing.

Sliding polynomials differ from other piecewise interpolation and smoothing methods in their functional continuity at the nodes. This functional continuity was used to establish optional spacing of nodes and optional boundary controls in data smoothing while still maintaining mathematically continuous rates or gradients. Cyclic as well as noncyclic data can be smoothed. Variance of the individual nodal values, derived through least-squares optimization, can be calculated using the rigorously determined weighting coefficients between data points and nodes. Such nodal variances are estimates of localized uncertainty in the data which complement the localization of smoothing through use of piecewise functions. Choice of controls in smoothing and calculation of variance were incorporated in a computer program for user convenience. (Sims-ISWS)
W80-05140

**THE EFFECT OF DATA INDEPENDENCE IN MODEL CALIBRATION AND MODEL TESTING,**
Maryland Univ., College Park. Dept. of Civil Engineering.
M. L. Shrader, R. H. McCuen, and W. J. Rawls.
Water Resources Bulletin, Vol 16, No 1, p 49-55, February 1980. 13 Tab, 6 Ref.

Descriptors: *Model studies, *Mathematical models, *Calibrations, *Hydrology, Rainfall, Runoff, Rainfall-runoff relationships, Hydrographs, Unit hydrogrphas, Regression analysis, Analytical techniques, Hydrologic data, Peak discharge, Data processing, Equations.

With the increased use of models in hydrologic design, there is an immediate need for a comprehensive comparison of hydrologic models, especially those intended for use at ungaged locations (i.e., where measured data are either not available or inadequate for model calibration). But some past comparisons of hydrologic models have used the same data base for both calibration and testing of the different models or implied that the results of model calibration are indicative of the accuracy at ungaged locations. This practice was examined using both the regression equation approach to peak discharge estimation and a unit hydrograph model that was intended for use in urban areas. The results suggested that the lack of data independence in the calibration and testing of regression equations may lead to both biased results and misleading statements about prediction accuracy. Additionally, although split-sample testing is recognized as desirable, the split-samples should be selected using a systematic-random samplin scheme, father than random sampling, because random sampling with small samples may lead to a testing sample that is not representative of the population. A systematic-random sampling technique should lead to more valid conclusions about model reliability. For models like a unit hydrograph model, which are more complex and for which calibration is a more involved process, data independence is not as critical because the data fitting error variation is not as dominant as the error variation due to the calibration process and the inability of the model structure to conform with data variability. (Sims-ISWS)
W80-05141

**DESCHUTES RIVER BASIN SUSPENDED SEDIMENT TRANSPORT STUDY,**
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 2J.
W80-05153

**PERTURBATION SOLUTIONS FOR WATER-TABLE AQUIFERS,**
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 2F.
W80-05158

**A GRAPHICAL COMPUTATION SYSTEM FOR THREE-DIMENSIONAL LAKE CIRCULATION AND CONTAMINANT DISPERSION,**
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
J. A. Liggett, R. H. Gallagher, J. Salmon, and G. Blandford.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 529-540, 1978. 6 Fig, 5 Ref, 1 Append. NSF ENG76-05029.

Descriptors: *Lakes, *Water circulation, *Path of pollutants, *Computer programs, Graphical meth-

ods, Equipment, Computers, Data processing, Mathematical models, Model studies, Finite element analysis, Analytical techniques, *Computer graphics, Graphical output, Display systems, Graphical input, Graphical computation.

As computer programs become larger, the major expense of calculation is often not the computer time but is the data preparation and interpretation of the output. A major liability of computer usage is the precise manner in which data must be supplied (cards or magnetic tape which generally are punched by hand in the first instance). The results usually appear as printed numbers, although computer-driven plotters have become common. Computer graphics alleviates these shortcomings by allowing the user to communicate with the computer--in both the input and output phases--in a quasi-analogue, operator-oriented fashion which seems more natural to the user. The computer itself takes on the primary function of data preparation, and it presents the results in a manner that can be interpreted easily and quickly. This paper described a graphics system which acts as a pre- and post-processor for the computation of three-dimensional circulation in homogeneous lakes. The convection and diffusion of a contaminant were included, which can lead immediately to an elementary pollution analysis. The full graphics capability was presented on a video tape which leads the viewer through the input, analysis, and results of an example. A description of the graphics system hardware was presented in the appendix. (See also W80-05159) (Sims-ISWS)
W80-05205

**SEDIMENT TRANSPORT IN MIGRATING BED FORMS,**
Science and Education Administration, Oxford, MS. Sedimentation Lab.
For primary bibliographic entry see Field 2J.
W80-05207

**CURRENT COMPUTER PRACTICES WITHIN CIVIL ENGINEERING,**
Maryland Univ., College Park. Dept. of Civil Engineering.
D. R. Schelling.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 791-799, 1978. 3 Fig, 1 Tab, 14 Ref.

Descriptors: *Computers, *Civil engineering, *Computer programs, Programming languages, Management, Soils, Hydraulics, Bridges, Documentation, Reviews, Structures, Computer practices, Computer uses, Software.

The current status of computer utilization within the civil engineering field was examined. Specific information pertaining to existing engineering computer programs, program sources and needs, computer hardware, language, documentation standards and practices were presented in condensed tabular form. The use of the computer within the practice of civil engineering is widespread and extremely diverse. The proliferation of computer programs and the associated duplication of effort is at least partially due to the incompatibilities between computer systems and the multilanguage environment. Coupled with this, the lack of adequate documentation on existing software effectively negates the usefulness of many existing programs. (See also W80-05159) (Humphreys-ISWS)
W80-05235

**ON THE SCALING OF LABORATORY OXYGENATION STUDIES,**
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Wasserbau III.
For primary bibliographic entry see Field 5G.
W80-05236

**MAPPING MODEL FOR DETERMINING LAND SUITABLE FOR IRRIGATION,**
Nebraska Univ., Lincoln. Dept. of Industrial and Management Systems Engineering.
R. O. Hoffman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-188683, Price codes: A02 in paper copy, A01 in microfiche. Nebraska Water Resources Center, University of Nebraska Final Report, April 28, 1980. 23 p, 3 Fig, 2 Tab, 7 Ref. OWRT A-039-NEB(1).

Descriptors: *Mapping, *Irrigable land, *Land classification, *Computer models, *Nebraska, Land use, Maps, Remote sensing, Soil types, Data processing, Aerial photography, Administration, Mathematical models, Algorithms.

CMS II, a computer composite mapping system, was adapted for use on the IBM 360, Model 198 computer system at the University of Nebraska for use in developing a Nebraska map showing land that is suitable for the development of irrigation systems. The CMS-II program is written in COBOL and the memory core requires 256 K bytes. CMS-II can be used to collate many forms of maps, taped data, and tabular data; grid size can be set as fine as the basic data will allow. The CMS-II program was tested using data from Dundy County located on the western edge of Nebraska. A land use mapping process was used based on viewing each piece of land on two separate color IR aerial photos, one taken in early summer and the other in late summer. Separate computer plots were produced for each of 27 types of land use. The program was also used to develop a mathematical model that predicts the number of acres that will be developed in future years for each soil series. Advantages of the CMS system are its ability to handle both quantitative and qualitative data and its inclusion of a factor weighing algorithm. CMS-II was found to be easy to use with high potential as a tool for analyzing the effects of water allocation and management. (Seigler-IPA)
W80-05246

**PHYTOPLANKTON-ZOOPLANKTON ASSOCIATIONS IN LAKE SUPERIOR: A STATISTICAL APPROACH,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05268

**WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1978.**
Geological Survey, Charleston, WV. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-153307, Price Codes: Microfiche only, MF/A01. Geological Survey Water-Data Report WV-78-1, November 1979. 357 p, 4 Fig.

Descriptors: *West Virginia, *Hydrologic data, *Surface waters, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Water wells, Water levels, Data collections, Sites.

Water resources data for the 1978 water year for West Virginia consist of records of stage, discharge, and water quality of streams and springs; stage and contents of lakes and reservoirs; and water levels in wells. This report contains discharge records for 118 gaging stations, stage only records for 3 gaging stations, stage and contents for 7 lakes and reservoirs, contents for 1 reservoir, change in contents for 1 reservoir, water quality for 47 gaging stations, and water levels for 31 observation wells. Also included are 3 crest-stage partial-record stations, and 4 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in West Virginia. (Kosco-USGS)
W80-05288

**WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1978.**
Geological Survey, Tucson, AZ. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-133556, Price codes: A99 in paper copy, A01 in microfiche. Geological Survey Water-Data Report AZ-78-1, November 1979. 604 p, 8 Fig.

Descriptors: *Arizona, *Hydrologic data, *Surface waters, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Water wells, Water levels, Data collections, Sites.

Water resources data for the 1978 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; water levels of observation wells; and quality of ground water. This report contains discharge records for 241 gaging stations, annual peaks for 77 crest-stage partial-record stations, and discharge measurements at 58 miscellaneous sites; contents only records for 9 lakes and reservoirs; stage and contents for 1 lake; elevations only for 2 lakes or reservoirs; gage height only for 1 lake and 1 head over a dam; 16 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; 2 low-flow investigations; water-quality records for 87 continuous-record stations and 16 miscellaneous sites; water levels for 101 observation wells; and water-quality data for water from 189 wells. The data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Federal and State agencies in Arizona. (Kosco-USGS)
W80-05289

**WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1978.**
Geological Survey, Helena, MT. Water Resources Div.
Geological Survey Water-Data Report MT-78-1, December 1979. 824 p, 11 Fig, 6 Tab.

Descriptors: *Montana, *Hydrologic data, *Surface waters, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Water wells, Water levels, Data collections, Sites.

Water resource data for the 1978 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 211 gaging stations, stage only records for 1 lake station, stage and contents for 9 lakes and reservoirs, water quality for 129 stations and 3 lakes, and water levels for 23 observation wells. Also included are 173 crest-stage partial-record stations and 52 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data-collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (Kosco-USGS)
W80-05290

# 8. ENGINEERING WORKS

## 8A. Structures

**COMPOUND WEIR DISCHARGE,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 8B.
W80-05194

**VERIFICATION OF PROTOTYPE SPILLWAY PERFORMANCE,**

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 8B.
W80-05195

**AN EXPERIMENTAL INVESTIGATION OF UPLIFT PRESSURES,**
Bechtel Incorp., San Francisco, CA.
A. Prakash, C. Arumugam, and A. Jagadheesan.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 396-406, 1978. 4 Fig, 1 Tab, 6 Ref, 1 Append.

Descriptors: *Hydraulic structures, *Dams, *Uplift pressure, *Model studies, Laboratory tests, Analog models, Groundwater, Groundwater movement, Pressure, Filters, Soil filters, Wells, Structures.

Impervious floors of hydraulic structures founded on pervious soils are subjected to uplift pressures caused by the seepage of water beneath the structure floor from the upstream to the downstream side. Groundwater movement under the foundations of structures with large width-to-lenght ratios is often treated as two-dimensional. But, for structures with smaller width-to-length ratios, groundwater movement in the lateral direction from or to the underside of the structure to or from the ambient water table significantly affects the distribution of uplift pressure, and the resulting flow pattern is three-dimensional. To simulate three-dimensional seepage below hydraulic structures, an electrical analog was developed, calibrated, and verified with field-measured values. The analog was used to predict three-dimensional seepage pressures on the floors of structures with (1) end and side sheet piles, and (2) intermediate filters and relief wells. It was assumed that groundwater movement was within the Darcy range; Dupuit-Forchheimer approximations held, and steady state conditions prevailed. (See also W80-05159) (Sims-ISWS)
W80-05196

**SURFACE FLOW IN A TWO-BAY WATER DIVERSION,**
Los Angeles County Flood Control District, CA.
T. L. Tanner, and Y. C. Kim.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 407-414, 1978. 4 Fig, 4 Ref.

Descriptors: *Diversion structures, *Flow, *Canals, *Model studies, Mathematical models, Hydraulic models, Intakes structures, Diversion dams, Clogging, Diversion, Hydraulics.

Surface flow patterns in a water diversion structure were synthesized by a hydraulic model and a mathematical model. The flow patterns for a steady state flow were evaluated to determine the influence of three operational schemes on an intake clogging problem caused by floating debris. The hydraulic model was a distorted scale model of the diversion structure. The mathematical model was a three-dimensional application of a finite difference relaxation method. The models indicated that by operating the diversion structure with the water-inflated dam nearest the diversion canal lower than the other dam, the problem would be minimized. (See also W80-05159) (Sims-ISWS)
W80-05197

**ROMAN WELLS,**
Hilleary and Associates, Catonsville, MD.
J. Hilleary.
Water Well Journal, Vol 34, No 5, p 71-72, May, 1980. 1 Fig.

Descriptors: *Water wells, *Dug wells, *Shallow wells, Construction, Well casing, Water pollution, Ground water, England, History.

Hand-dug wells in England were constructed by Roman laborers in shallow, unconsolidated aquifers. A 3x3 foot square of oak planks functioned as supports and frames for side panels. Water seeped in through the sides and bottom of the well. Upon completion of the well, the pit was backfilled and a housing built over it. Water was lifted by means of a rope attached to a wooden bucket. When the wells were abandoned, they became trash collectors and contaminated newer wells dug nearby. Another style of Roman well construction was the stone and wooden well in which the stone was inserted on the bottom half of the well and oak planking installed on the upper half. Barrel casings were sometimes used as long as the barrel staves did not collapse and the well depth was less than 4 feet. Although many barrel-cased wells have been clogged for centuries the oak staves are in remarkable condition. A willow basket casing made of twigs of willow woven into a strong and coherent fabric was also used for shallow wells. (Purdin-NWWA)
W80-05245

## 8B. Hydraulics

**MINIMUM REYNOLDS NUMBERS FOR PHYSICAL MODEL SIMILARITY,**
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
A. F. Babb, J. Amorocho, and C. Lomax.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 61-69, 1978. 6 Fig, 4 Ref.

Descriptors: *Hydraulic similitude, *Hydraulic structures, *Reynolds number, *Hydraulic models, Model studies, Flow characteristics, Open channel flow, Surge tanks, Orifices, Siphons, Outlet works, Flow system, Free surfaces, Froude numbers, Energy loss, Gates, Conveyance structures.

This paper discussed several model investigations where minimum Reynolds numbers have been identified. The geometries tested were varied and involved flow systems of both the free surface and closed types. Included are studies of open channel warped transitions for the California Aqueduct, surge tank orifices for the Helms Pumped Storage Project in California, and siphon outlet structures also designed for use with pumping plants in the California Aqueduct. Results of tests presented give minimum Reynolds numbers for physical model similarity for some shapes not generally available in the literature. The tested shapes consisted of a warped open channel transition, a surge tank orifice, and a pump discharge line siphon outlet structure. In general, the model scales selected for the studies were large enough to permit model tests to be conducted at Reynolds numbers exceeding the minimum value for acceptable model-prototype similarity. The study on the warped transitions illustrated the importance of simulating approach conditions in the determination of energy loss coefficients. (See also W80-05159) (Humphreys-ISWS)
W80-05164

**A HYBRID COMPUTER SYSTEM FOR GROUNDWATER MODELING,**
South Florida Water Management District, West Palm Beach.
For primary bibliographic entry see Field 2F.
W80-05175

**PHYSICAL MODEL STUDY FOR IMPROVED NAVIGATION CHANNEL DESIGN,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
H. O. Turner, Jr.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 265-272, 1978. 6 Fig, 5 Ref, 1 Append.

Descriptors: *Navigation, *Channels, *Ships, *Model studies, Hydraulic models, Laboratory tests, Design, Reynolds number, Waves(Water), Canals, Navigable waters, Analytical techniques, Research facilities, Hydraulic similitude, Navigation channels.

The U.S. Army Engineer Waterways Experiment Station is currently conducting a study to determine the minimum dimensions of deep-draft navigation channels. These minimum dimensions will include the various safety aspects so as to provide for safe and efficient navigation. This research study is being conducted with free running remote-controlled scale models of prototype ships. The objective of the model study is focused on the improvement of navigation channel design methods and not necessarily a study of ship maneuverability improvements. The model ships will be used as a means of evaluating the channels being tested. (See also W80-05159) (Sims-ISWS)
W80-05182

**MATHEMATICAL MODELS FOR NAVIGATION CHANNEL DESIGN,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
C. J. Huval.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 273-279, 1978. 4 Fig, 11 Ref.

Descriptors: *Navigation, *Channels, *Ships, *Model studies, Mathematical models, Canals, Navigable waters, Design, Analytical techniques, Simulation analysis, Navigation channels.

The U.S. Army Engineer Waterways Experiment Station has recently undertaken an investigation to determine the minimum dimensions of deep-draft navigation channels compatible with the assurance of safe operating conditions. The study will provide the necessary information to improve existing channel design criteria. The research effort was initially designed to employ only a physical scale model with several types of free-running model ships navigating a variety of possible channel configurations. However, during the early phases of the project, it was thought desirable to undertake a review of potentially useful mathematical models and ship simulators. This paper summarized the study of the applicability of ship simulators, physical models, and mathematical model techniques for use in the study of navigation channel improvements and design. Neither of the three analysis methods alone can provide all the required information to design a navigation channel. Each of the three research techniques has unique capabilities and deficiencies. The three research methodologies should be used jointly in a complementary fashion. (See also W80-05159) (Sims-ISWS)
W80-05183

**RADIAL SOURCE-SINK FLOW IN STRATIFIED OCEAN,**
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
G. H. Jirka, and R. P. Johnson.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 311-316, 1978. 4 Fig, 4 Ref.

Descriptors: *Flow, *Water circulation, *Model studies, Mathematical models, Energy, Oceans, Stratification, Density stratification, Thermal stratification, Hydraulics, Ocean thermal energy conversion.

Ocean thermal energy conversion (OTEC) is a method of generating power using the vertical temperature gradient of the tropical ocean as an energy source. The upper layer of the ocean collects heat energy by absorbing solar radiation. The underlying water is colder due to the return flow from polar regions which occurs within the global circulation of the world ocean. Thus a temperature-stratified system is formed. The vertical salinity distribution is usually locality dependent. However, its effect on density is generally much weaker than that of temperature. In total, a stable density

stratified system is formed consisting of a thin upper layer (in the order of 100 m (300 ft)) and a deep lower layer separated by a thermocline-pycnocline with strong gradients of temperature and density. Various OTEC design options and associated problems of research and development have been described elsewhere. One of the critical problems from a hydrodynamic standpoint is the potential for recirculation. Recirculation is defined as the repeated intake of diluted water which has passed through the evaporator or condenser. Recirculation would have detrimental effects on plant efficiency due to a further reduction of the available temperature difference and possible adverse environmental impact due to the local accumulation of chemicals used in plant operation. This paper presented a schematic approach to the problem which is believed to yield realistic first-order estimates of the recirculation potential for purposes of plant design evaluation. The analytical approach was verified with laboratory experimental data. (See also W80-05159) (Sims-ISWS)
W80-05186

**VORTEX FORMATION IN A POWERPLANT COLLECTION BASIN,**
Florida Univ., Gainesville. Coastal and Oceanographic Engineering Lab.
Y-H. Wang, G. Powell, and J. B. Miller, Jr.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 335-342, 1978. 4 Fig, 2 Tab.

Descriptors: *Vortices, *Structures, *Discharge(Water), *Model studies, Hydraulic models, Pipes, Flow, Air entrainment, Water levels, Basins, Heated water, Powerplants, Hydraulics, Discharge structures.

During the design of a basin to collect hot water from three units of a southeastern utility's central power station, concern arose as to whether a vortex would form at the entrance to the discharge pipe from the basin. The collection basin and discharge pipe are being constructed in order to relocate the plant's thermal discharge from its current location in a tidal estuary to a large river approximately 3000 feet away. The maximum flow rate through the 196 inch pipe would be 569,000 gpm. This question of a vortex formation is difficult to answer due to the complicated dynamics and boundary conditions. Since this problem was not amenable to purely analytical techniques, a hydraulic model was deemed most appropriate. The objectives of the model study were to determine qualitatively: (1) whether there would be a vortex formation at the entrance to the discharge pipe capable of entraining air into the pipeline, and (2) if so, what measures could be taken to alleviate such a problem. (See also W80-05159) (Sims-ISWS)
W80-05188

**COMPOUND WEIR DISCHARGE,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
F. W. Blaisdell, and C. L. Anderson.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 381-388, 1978. 4 Fig, 1 Ref, 2 Append.

Descriptors: *Weirs, *Discharge(Water), *Channels, *Model studies, Mathematical models, Design, Structures, Hydraulic structures, Flow, Orifices, Orifice flow, Erosion, Hydraulics, Compound weirs.

A weir, U-shaped in plan and compound-trapezoidal-shaped in elevation, was sized to fit a head-discharge relationship predetermined by site requirements. An imposed site limitation was a constructed channel in a wide flood plain. The initial design was a box inlet weir, U-shaped in plan and trapezoidal in elevation. The bank-full capacity of this spillway exceeded the channel capacity. This caused the approach channel water surface to drop down upstream of the spillway. To prevent overbank flow from dropping into the approach channel and eroding the banks in the vicinity of the drop structure, the drop spillway capacity at bank-full head had to be decreased to equal the bank-full channel capacity. This was accomplished by a low level weir U-shaped in plan and trapezoidal in elevation of less capacity than the original weir. To limit the head rise for floods exceeding the channel capacity, a lengthened crest was required. This was accomplished by superimposing on the low level weir a long high level weir with its crest at the flood plain level. The high level weir was also U-shaped in plan and trapezoidal in elevation. The final weir proportions met the imposed requirements. The head-discharge relationship for the compound weir was mathematically modeled by developing (straightening out or linearizing) the U-shaped crest, separating the developed crest into elements, and analyzing the elements as rectangular and triangular weirs and a triangular orifice. The analysis was verified and the discharge coefficients were evaluated by a physical model. (See also W80-05159) (Sims-ISWS)
W80-05194

**VERIFICATION OF PROTOTYPE SPILLWAY PERFORMANCE,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
C. L. Anderson, and F. W. Blaisdell.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 389-395, 1978. 7 Fig, 1 Ref.

Descriptors: *Spillways, *Hydraulic structures, *Model studies, Hydraulic models, Flow, Discharge(Water), Structures, Laboratory tests, Hydraulics, Drop spillways, Inlet structures.

Flow phenomena which could not be explained occurred in the principal spillway of the Marsh Creek Dam of the Marsh-Kellogg Watershed Project in Contra Costa County, California. Analyses of hydrologic data recorded in January 1967 revealed differing head-discharge relationships for rising and falling stages of the outflow. Also, during the falling stage of a January 1969 runoff, significant flow was observed through the spillway even though the reservoir level was below the spillway crest level. Engineers inspecting the spillway in June 1972 had differing explanations for the spillway performance and the effect of the air vents in the drop inlet. To resolve the differences expressed by experienced engineers and to explain the unusual performance of the prototype, a model study was conducted in 1973. The prototype and its performance and the model and its reproduction of the prototype performance were described and illustrated. (See also W80-05159) (Sims-ISWS)
W80-05195

**SURFACE FLOW IN A TWO-BAY WATER DIVERSION,**
Los Angeles County Flood Control District, CA.
For primary bibliographic entry see Field 8A.
W80-05197

**ANALYSIS OF SUB- AND SUPERCRITICAL DAM-BREAK FLOWS,**
Michigan State Univ., East Lansing. Dept. of Civil Engineering.
D. C. Wiggert, and C. S. Martin.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 680-689, 1978. 5 Fig, 13 Ref.

Descriptors: *Dam failure, *Waves(Water), *Theoretical analysis, *Mathematical models, Flow, Model studies, Flood waves, Bores, Analysis, Floods, Methodology, Numerical analysis, Analytical techniques, Subcritical flow, Supercritical flow, Dam break, Method of characteristics.

Following a review of the analytical solution, two numerical models were adapted to model the idealized sudden dam break flow. The method of characteristics and the implicit scheme employ a fixed grid in the time-distance plane and are known to possess the ability to transmit discontinuities, or bores, of weak to moderate strength. In addition, the method of characteristics can facilitate subcritical or supercritical flows. Based on the criterion of bore height and discharge at the dam, the implicit scheme and the method of characteristics were shown to approximate the idealized dam break solution in which initial flow in the system may exist. Whereas the implicit scheme is valid only for subcritical flows, the method of characteristics can be applied to a mixed flow regime. (See also W80-05159) (Humphreys-ISWS)
W80-05223

**VERIFICATION OF TRANSIENT MIXED-FLOW MODEL,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
C. C. S. Song.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 690-701, 1978. 6 Fig, 8 Ref.

Descriptors: *Mathematical models, *Mixing, *Flow, Model studies, Calibrations, Open channel flow, Closed conduit flow, Analytical techniques, Mathematics, Analysis, Hydraulic models, Mixed flow.

In order to optimize the use of existing or new combined sewer systems for pollution abatement, it may be necessary to make use of the in-line storage capacity as well as their capacity to convey water and sewage. Flow in such a system would undergo the change of flow regimes in a typical sequential manner, open channel-mixed-closed conduit-mixed-open channel, at a large storm event. A mathematical model capable of dealing with the unsteady variable regime flows is necessary to help design such a system. This paper explained some features and the calibration process of a model constructed for the Pure Water District of Monroe County, New York. It was demonstrated by comparing a physical model with a mathematical model that the transient flows with phase change can be satisfactorily modeled mathematically. The major problem in the mathematical model is the jump condition associated with the moving interface. (See also W80-05159) (Humphreys-ISWS)
W80-05224

**DEVELOPMENT OF MAKEUP LINE SAFE OPERATING CRITERIA,**
Bechtel Inc., Norwalk, CA.
P. K. Su, and I. Joseph.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 702-714, 1978. 8 Fig, 2 Tab, 1 Ref, 1 Append.

Descriptors: *Unsteady flow, *Pipelines, *Flow system, *Model studies, Thermal powerplants, Pressure conduits, On-site tests, Computer models, Pumping, Water delivery, Automatic control, Hydraulics, Flow, Fluctuations, Operations, Simulation analysis, Water levels, Pressure, Makeup water.

A field experiment and mathematical analysis of the hydraulic transients were performed on the makeup lines of the Navajo Generating Station. The makeup line hydraulic transient analysis was performed using Bechtel's hydraulic transient analysis program. This transient analysis was performed to calibrate the computer model in order to reproduce the field data. After adjusting the head loss coefficients of the pipeline and the shock-trap orifice in the mathematical model, the results show a satisfactory agreement between the measured and calculated transient response at the shock-traps and several points along the pipeline. The mathematical model was then used to develop system operating criteria which includes automatic control of the water levels in the shock-trap for various flow rates. The system is protected from adverse tran-



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sient effects due to power interruptions. (See also W80-05159) (Humphreys-ISWS)
W80-05225

**THE LOYALSOCK CREEK MODEL STUDY,**
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
A. C. Miller, R. A. Chadderton, and S. A. Brown.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 745-752, 1978. 1 Fig, 2 Tab, 9 Ref.

Descriptors: *Hydraulic models, *Bank erosion, *Streams, *Pennsylvania, Model studies, Erosion control, Bank protection, Calibrations, Backwater, Profiles, Slope protection, Floods, *Loyalsock Creek(PA).

A physical model of the Loyalsock Creek meander immediately upstream of Pennsylvania State Highway 220 (Legislative Route 1073, Section C-17) was constructed on a 1 to 90 scale, both in the vertical and horizontal dimensions. The undistorted model was constructed to achieve quantitative velocity and depth measurements for a wide range of flow magnitudes. No attempt was made to model a partially moveable boundary because of the restrictively small model scales involved. The study has progressed with testing and analysis of the undistorted, fixed bed model, Phase I. Model data and analyses presented indicate a substantial potential for further erosion of the east bank of Loyalsock Creek as the meander continues to grow. Flood flows will also create potential to erode the existing rock protection that has placed along the south bank of the Mill Creek realignment channel and the lower east bank of Loyalsock Creek. Phase I testing did not indicate any eminent danger of the highway embankment being breached from any one particular storm; however, long-term effects were not studied and will be included in the second phase of the research. (See also W80-05159) (Humphreys-ISWS)
W80-05229

**SEDIMENT MODEL VERIFICATION FOR SMALL DIVERSIONS,**
Water and Power Resources Service, Denver, CO.
For primary bibliographic entry see Field 2J.
W80-05230

**ON THE SCALING OF LABORATORY OXYGENATION STUDIES,**
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Wasserbau III.
For primary bibliographic entry see Field 5G.
W80-05236

**UNIFIED PRESENTATION OF BUOYANT SURFACE JETS IN THREE DIMENSIONS,**
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering and Applied Mechanics.
R. E. Baddour, and V. H. Chu.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 811-818, 1978. 6 Fig, 8 Ref.

Descriptors: *Jets, *Buoyancy, *Flow characteristics, *Model studies, Laboratory tests, Flow, Analysis, Analytical techniques, Turbulent flow, Spatial distribution, Saline water, Heated water, Freshwater, *Surface jets, Buoyant jets, Wall jets, Two phase flow.

The paper discussed a buoyant wall jet in three dimensions. The wall jet was simulated in the laboratory by injecting saline water along a flat bottom in a tank of fresh water of lighter density. Basic properties related to the development of three-dimensional buoyant shear layers in general were discussed from the results of the wall jet experiment. These properties were used to interpret results of heated surface jets. The results presented are the first part of a larger investigation and perhaps raise more questions than can be answered. Future investigation should pay more attention to the temperature distribution in the region outside the turbulent core. The rather unusual buoyancy distribution presented has suggested a region of relatively high temperature which may occur on the two sides of the jet. (See also W80-05159) (Humphreys-ISWS)
W80-05237

**BIFURCATION OF BUOYANT JETS IN A CROSSFLOW,**
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering and Applied Mechanics.
M. S. Abdelwahed, and V. H. Chu.
In: Verification of Mathematical and Physical Models in Hydraulic Engineering; Proceedings of the 26th Annual Hydraulics Division Specialty Conference, Maryland University, College Park, August 9-11, 1978, p 819-826, 1978. 10 Fig, 3 Ref.

Descriptors: *Jets, *Flow characteristics, *Model studies, Laboratory tests, Open channel flow, Analysis, Analytical techniques, Data collections, Spatial distribution, *Buoyant jets, Crossflow, Bifurcation, Two phase flow.

Bifurcated jets were simulated in the laboratory by discharging hot or cold water into an open channel crossflow through an orifice located at the channel bottom. The jet was observed first to bend over and form a pair of vortex-like turbulent elements. As the jet impinged on the free surface, it bifurcated into two separated regions; between them a clear space extended continuously. Due to restriction by the width of the crossflow channel, it has not been possible to investigate quantitatively the spreading behavior of the bifurcated jet in the far field region. But based on some qualitative observations at very low crossflow velocity, the pair of bifurcated vortex was observed in the far field region to break down into two rolls of counter-rotating vortex street. The breakdown is apparently the result of suppression of vertical motion due to gravity stratification. In the course of rotating the vortex vector toward the vertical direction the vortex pair breaks down into vortex street. It is difficult to know whether entrainment would stop in a vortex street. The entrainment coefficient obtained in the present experiment was found to depend rather weakly on the Richardson number. This might be an indication that entrainment does not vanish but approaches a constant in the far field region. Further experimentation in a wider channel is obviously needed to settle this question. (See also W80-05159) (Humphreys-ISWS)
W80-05238

# 10. SCIENTIFIC AND TECHNICAL INFORMATION

## 10F. Preparation Of Reviews

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For primary bibliographic entry see Field 6E.
W80-05154

**CURRENT COMPUTER PRACTICES WITHIN CIVIL ENGINEERING,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W80-05235

**ORGANOCHLORINE SUBSTANCES IN LAKE SUPERIOR,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W80-05274

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## ABSTRACT SOURCES

| SOURCE | ACCESSION NUMBER | TOTAL |
|---|---|---|
| A. CENTERS OF COMPETENCE | | |
| Illinois State Water Survey, Hydrology | W80-05119--05154<br>05159--05241<br>05251--05287 | 156 |
| National Water Well Association, Water Well Construction Technology | W80-05158, 05245<br>05322 | 3 |
| University of Florida, Eastern U. S. Water Law | W80-05363--05400 | 38 |
| B. STATE WATER RESOURCES RESEARCH INSTITUTES | W80-05101--05103<br>05156--05157<br>05249<br>05328--05333 | 12 |
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| Environmental Information Services, Inc. (Effects of Pollutants on Aquatic Life) | W80-05250 | 1 |
| Forest Service (USDA) | W80-05334 | 1 |
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**Subject Fields**

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

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| A19 | 22.00 | E19 | 50.50 | T19 | 1,200.00 |
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